THE
ELECTRICAL REVIEW.

VOL. L. MARCH 28, 1902. No. 1,270.

CONTENTS:

	PAGE
Conversion of Our Railways	497
The National Physical Laboratory	499
Nelson Electricity Works Extensions (*illustrated*)	500
The Industrial Freedom League	501
The Design of Continuous-Current Dynamos	502
The Eastern and South African Telegraph Company, Limited, *v.* Cape Town Tramway Companies, Limited	502
Correspondence:—	
Overhead Mains (*illustrated*)	504
Corporation Tramways and Emergency Brakes	504
Technical Terminology	505
500-Volt Electric Shocks	505
Polyphase Working	506
The Testing and Management of Electric Motors	506
The Harburg I.R.C. Company and Ferd. Winter *v.* Browne Martin	506
Legal	506
Parliamentary	507
Business Notes	509
Supply Station Accounts	519
City Notes	520
Traffic Receipts	524
Stocks and Shares	524
Share List of Electrical Companies	525
Market Quotations	526
Institution of Electrical Engineers (Manchester Section):—	
Electric Furnaces (*illustrated*)	527
Electric Shocks (*illustrated*)	528
Current Specifications.—XCV.	530
The Board of Trade Report on the Liverpool Railway Accident	530
Tunbridge Wells Telephones (*concluded*)	531
The Influence of Tariffs on Electricity Supply (*concluded*)	534
Central Station Losses	535
New Patents	536
Abstracts of Published Specifications	536

THE
UNIVERSAL ELECTRICAL DIRECTORY

1902 Edition
READY.

H. ALABASTER, GATEHOUSE & CO.,
4, Ludgate Hill, London, E.C.

THE ELECTRICAL REVIEW.
Published every FRIDAY, Price 4d.
The Oldest Weekly Electrical Paper. Established 1872.
TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON, E.C.

Telegraphic Address: "AGEEKAY, LONDON." Code, A B C.
Telephone No. 933 Holborn.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades, AND HAS
BY FAR THE LARGEST CIRCULATION
of any Electrical Industrial Paper in Great Britain.

SUBSCRIPTION RATES.—In Great Britain, Post Free per Year, 19s. 6d. To all other countries, per Year, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. Paris: VEUVE J. BOIVEAU, 22, Rue de la Banque. Berlin: ASHER & Co., 13 Unter den Linden.

Cheques and Postal Orders (on Chief Office, London), to be made payable to Mr. H. ALABASTER, 4, Ludgate Hill, E.C.

CONVERSION OF OUR RAILWAYS.

THIS problem is one which is at present occupying the mind, not only of the engineer, but also of the man in the street. The crowded meetings at the Institution of Civil Engineers, and the large number of persons who have taken part in the discussion on Messrs. Mordey and Jenkin's paper, show the great interest which the subject awakens.

We have already dealt with Messrs. Mordey and Jenkin's paper in our issue of February 28th, and the importance of the subject warrants our treating Mr. James Swinburne's paper on "The Electric Problem of Railways," read before the Manchester Section of the I.E.E., in the same manner.

Generally speaking, the paper contains nothing new, nor is any description given of work or experiments carried out, or of results obtained, and, as far as any practical information is concerned, none is given. It must, however, be granted that Mr. Swinburne's suggestions and conclusions are much more rational than those advanced by Messrs. Mordey and Jenkin in their paper before the Institution of Civil Engineers.

Mr. Swinburne is anxious "that we should not merely drift into a practice which may not be the best," and on this point we quite agree with him. But we do not think that any engineer who has had any real experience, or is acquainted with what is going on in Europe and America, would think of extending the tramway system to meet the case of a long main line railway or crowded suburban line.

In no case has what may be called tramway practice been adopted in operating metropolitan railways either in Europe or America. Trains with larger motors and some sort of multiple unit control or hauled by locomotives have been used, and no overhead wires have been employed. Heavy trains, and rapid accelerations, exceeding in some cases 18 in. per second per second, have been employed, and, if anything, the practice of existing steam railways has been followed, and not of tramways, as Mr. Swinburne seems to fear. All the large electrical manufacturers have adopted some type of multiple unit control, all of which have, in practice, given more or less satisfactory results. As regards the central station part of the problem, it is very similar to tramway practice, except that, unless the number of trains is very large, the variation of load is much greater in the case of a railway operating heavy trains, instead of a larger number of independent motor cars.

As regards the suggestion of running single motor cars, it will at once be seen that if suburban and metropolitan lines are considered, it will be impossible. In this case, between certain hours of the day, the passengers have mostly to be carried to and from business, and with trains following on the shortest headway which safety permits, it is all that a railway can do to carry the passengers who are seeking transportation, even when using the longest train which the platforms of the stations permit.

We cannot agree with Mr. Swinburne's contention that

the suburban and main lines cannot be considered separately; this was the chief reason advanced by Major Cardew at the Arbitration, for advocating the use of what was called the Ganz system in the case of the Inner Circle. The question of operating our long-distance lines electrically is as yet too far off to demand minute consideration, much less to impose the system to be adopted in the electrification of our metropolitan and suburban lines.

The fascination of the equipment of long-distance lines electrically seems to have been too great for Mr. Swinburne, and, following in Mr. Langdon's footsteps, he has considered long-distance lines as well as metropolitan lines.

Mr. Swinburne gives a series of elementary calculations, all of which are in the C.G.S. system, which for mathematical reasons may be all right, but which is strange and unfamiliar to the engineer engaged in railway work. It is true that the equivalents in English units are always given, but that is of little use when the acceleration is given as "1·1 yards per second per second," instead of either in feet or inches.

Mr. Swinburne then considers it necessary to go all over the well-worn subject of shunt *versus* series wound motors, and enumerates the various other methods and combinations of continuous and alternating-current systems which have been adopted. Theoretical results as to efficiency and power consumption are given, which, as all those who are acquainted with traction work know, are of little real value.

We doubt very much whether any experienced manufacturer would care to build a 3,000-volt 250-H.P. traction motor. Mr. Swinburne seems rather favourably inclined towards the constant-current system, which has been tried and abandoned, and which we do not think would ever be recommended by any engineer having a large practical experience of traction. The author seems very much afraid that somebody is anxious to convert "our railways into electric street tramways," but we are left in the dark as to what are his reasons for this fear, and without some explanation we must confess that we are at a loss to understand it.

The chief problem before the country to-day is one which demands to be taken in hand at once by all our large railway companies, and one which we have always pressed—the electrification of the suburban lines in our large cities. This must be done if the railways wish to retain, if not increase, their suburban traffic, as we pointed out in an article on "Tramway Competition" in our issue of March 7th.

While impressing on the railway companies, especially those in London, the absolute necessity of at once tackling the problem of equipping their suburban lines electrically and boldly attacking the problem as a whole, not piecemeal and experimentally as was done in the ridiculous waste of money on the Earl's Court and Kensington experiments, we must at the same time add a word of warning. Somehow or other, as is often the case, the daily press and the man in the street have got hold of the idea that some of our railways are contemplating the transformation of their main lines—an idea which has been unfortunately encouraged by the President of the Institution of Electrical Engineers in many of his addresses, and which we have already criticised in our columns. This belief is a very dangerous one, as it leads to the idea that in the electrification of our suburban lines the chief point to be considered is to make the system there adopted fit in with that which might eventually be used on our main lines. This will not only lead to the retardation of the equipment of our suburban lines, but might also cause the wrong system to be employed.

It has never yet been absolutely shown that electric traction is cheaper than steam traction as far as long-distance lines are concerned, except possibly in countries where free water-power is available in sufficient quantities.

We do not wish to be thought opposed to the adoption of electric traction on main line railways, but we wish to guard against possible financial disaster, which would put back electric traction for years, as would be the case if the public rushed in and financially backed some long-distance high-speed electric railway, which might bring in money to the promoters, but would certainly ruin the shareholders. Whilst urging that immediate steps be taken to electrically equip the suburban lines in our large cities, we must warn our readers, and especially the general public, against the plausible arguments advanced by unprincipled promoters.

The Finchley Case.

In the case of the Finchley Electric Lighting Company *v.* the Finchley Urban District Council, a report of which will be found in another column of the present issue, a very important point in relation to overhead wires was discussed. The case has been dealt with in its early stages in the Review, but it may be convenient at this place to call attention once more to the salient features. The Finchley Urban District Council are possessors of a provisional order for the supply of electric light in their district. Although they obtained this order in 1899, it has never yet been put into force. The plaintiffs are a private company who saw an opportunity of supplying the inhabitants of Finchley with electric light upon reasonable terms. With this object they established a small generating station and a system of mains. In order to extend their system, it was found necessary to lay mains across highways in the district, and with a view to laying such mains they applied from time to time to the defendant Council for leave to turn up the streets. This leave being refused, the company were driven to making use of overhead wires. By arrangement with landed owners on either side of the Regent's Park Road, they erected posts from which it was possible to suspend a wire supporting a cable at a height of 34 ft. above the surface of the street, and out of the way of the traffic. Realising that if the company's system could be extended throughout the district by such means, their prospective consumers might be enticed away, the Council immediately instructed their surveyor to interfere. He at once ordered the main in question to be removed, and his direction having been carried out, the company commenced the present action and applied to the vacation judge last October for an interim injunction to restrain the commission of further acts of a similar kind. The Lord Chief Justice granted the injunction, which remained good until the hearing before Mr. Justice Farwell. The case then set up on the part of the Council was shortly this:—"We are owners in fee simple of the soil of the highway; we are therefore entitled to remove anything erected over that highway, as it constitutes a trespass upon our property." The proof of this case involved the consideration of statutes dating back to the early part of last century—but the title was proved and the learned judge was compelled to refuse the plaintiffs the relief which they sought. In the end he dismissed the action, but *with-*

out costs. The facts of this case throw a lurid light upon the tactics of municipal traders. When the highway in question became vested in the Urban District Council of Finchley as highway authority, it was never contemplated that they would do more than protect the interests of the public who use the road. A cable securely fastened at a height of 34 ft. above the metal, could never interfere with the passing traffic; it is all too plain that the object of the Council in standing upon their strict rights was to nip the growth of a rival in the bud. We presume that the *pro bono publico* argument will be forthcoming in order to justify this conduct; but what of the inhabitants of Finchley who have waited for years, and are still destined to wait for a proper supply of electricity? What of the bill of costs which must be paid by the ratepayers? Another consideration forces itself into notice. The District Council, by their action in this matter, have laid the foundation stone of an electric lighting monopoly in their district. Time has yet to show whether their prices will compare favourably with those at which the company were prepared to furnish a satisfactory supply.

Amendment of the Patent Law.

Prof. S. P. Thompson in a letter to the *Times*, proposes to add a clause to the Patents Bill at present before Parliament, to the effect that the disclosure of an invention before one of the learned societies by a fellow or member shall not prejudice the right of the inventor to apply for, and obtain, protection and a valid patent for the same, provided such application be made within two years. As an example of the injustice of the present arrangement, he quotes the invention of the microphone by Prof. Hughes, who lost all benefit from his invention, because he described it to the Royal Society before he applied for a patent. Prof. Thompson does not give any reason why the fellow of a learned society could not apply for a patent before he reads his paper, but, as a matter of fact, Hughes never intended to patent the microphone (see our "Notes" columns). Provisional protection does not cost much, and appears to give the inventor all that he would get by the amendment proposed. That every learned society should be a sort of a junior patent office for the registration of inventions, would in our opinion be an intolerable nuisance to everybody having anything to do with inventions. It would interfere with the progress of invention, since few would risk patenting improvements with a fear of a possible master patent coming into existence, which would certainly reduce, and perhaps destroy completely, the value of their patent rights. Prof. Thompson cites the practice of the United States in favour of his proposal, but in the United States there is no provisional protection such as we have here. The new Patents Bill proposes to reduce the period of provisional protection from nine months to six months. Prof. Thompson proposes practically to increase it to two years—at least for the fellows of learned societies. The unfortunate outsider is only to be allowed the six months proposed by the Bill, in which to decide whether his invention is worth patenting or not.

Deputations from the Council of the Chartered Institute of Patent Agents and from the Manchester Chamber of Commerce waited last week upon the President of the Board of Trade, to lay before him their views on the question of the compulsory working of patents. The Patent Agents' deputation strongly opposed the introduction of a compulsory working clause in the new Bill. Mr. Philip McJustice, the president of the Chartered Institute of Patent Agents, argued that manufacture for the mere purpose of complying with the requirements of a working clause had no practical effect in promoting native industry, but it had a great effect in discouraging inventors from taking out patents, and subsequently in destroying their patent rights when acquired. We are inclined to agree with the Patent Agents on this point. If the law provides effective machinery for granting compulsory licences, that ought to be sufficient to frustrate any attempt by foreigners to put our manufacturers at a disadvantage by refusing to work patents granted to them in this country.

THE NATIONAL PHYSICAL LABORATORY.

The National Physical Laboratory, which has been located in Bushy House, Teddington, was on Wednesday last week formally opened by the Prince of Wales in the presence of a distinguished company. The germ of the idea which has now at last been, to some extent, realised, is due to Dr. Lodge. Sir Douglas Galton took an active part in promoting the scheme. He investigated the working of the corresponding German Institution, the Reichsanstalt, at Charlottenburg, and was chairman of a British Association Committee which reported strongly in favour of the establishment of a National Physical Laboratory in 1896. The Treasury was at length persuaded to take up the scheme, and appointed a committee, with Lord Rayleigh as chairman, to investigate and report. This committee examined witnesses representing the scientific side, and industries depending on scientific discoveries. They also visited the German institution; and finally reported strongly in favour of the establishment of a corresponding institution in this country.

Though we have had, up to the present, no Government Department corresponding completely to the German Reichsanstalt, we have had in existence for some time two departments which have carried out part of its functions. The Standards Department was attached to the Board of Trade in 1878, with the duty of making standards of length, weight and capacity, and in 1889 it was further empowered to make such new standards for the measurement of electricity, temperature and gravities as appeared to be of use for trade. This department possesses, under the Gas Acts, powers as to a standard of light. The Incorporated Kew Observatory, the other department, that has for many years been doing useful scientific work, is administered by a committee of the Royal Society. It standardises between 30 and 40 different kinds of instruments, such as thermometers, barometers, watches, photographic lenses; it also carries out routine observations—magnetic, meteorological, &c.—and does a certain amount of experimental work in connection with these observations.

The Kew Observatory and its work is now to be absorbed into the National Physical Laboratory, which, however, will carry out original research on a much more extensive scale than has hitherto been done at Kew.

Though we have now made a good start, we still are a long way behind our rivals. The original idea of the German Reichsanstalt emanated from Helmholtz and Dr. Werner Siemens, who presented the site of 11 acres and £12,000 in aid of the building; the German Government undertaking the construction of the building and its endowment. The total capital expenditure on the Reichsanstalt has been £201,625, and the annual expenditure is over £16,000. The Bill for the establishment of a National Laboratory in America, which lately passed through Congress, authorised an expenditure of £60,000 and a yearly grant of £9,000. The sum which has been expended by our Government amounts to about £19,000, and the annual grant is £4,000. Our expenditure is evidently ridiculously small when compared with that of our two great commercial rivals. Considerable financial aid, however, is expected from private sources, and already some handsome contributions have been made. The Institution of Naval Architects has undertaken to defray the cost of a tank after the design of the late Mr. Froude, for testing the stability of ships; and the Prince of Wales was able to announce before the end of the opening ceremony that Sir William Armstrong, Whitworth & Co. had promised to subscribe £1,000, an excellent example which he hoped would be followed.

The largest room in the National Physical Laboratory is the engineering laboratory, which is a new building specially erected for the purpose at some distance from Bushy House. It contains a few machine tools, but appears to be as yet very poorly furnished with the necessary apparatus. The physical laboratories are mostly in the basement of Bushy House. The electrical laboratory contains a very fair equipment of the principal measuring instruments at present in favour. Amongst others we observed Ewing's permeability bridge, Thomson's bridge for low resistances, Kelvin's ampere balance, Cardew's

voltmeter, a potentiometer, and a Kelvin electrometer. The metrology laboratory contains a very fine dividing engine, presented by Sir Andrew Noble. In this instrument the graver is mounted on the frame, and the plate to be graduated is fixed on a saddle traversed by the leading screw. The different lengths of lines at the end of five and ten graduations are drawn automatically by means of mechanism which controls the movements of the graver. A fine micro-photographic apparatus for photographing, for example, magnified sections of steel, was on view. The light from an arc lamp is concentrated on a very small area of the surface of the steel, which is then magnified and projected on the focal plane of the camera. A small but well fitted chemical laboratory also forms part of the establishment.

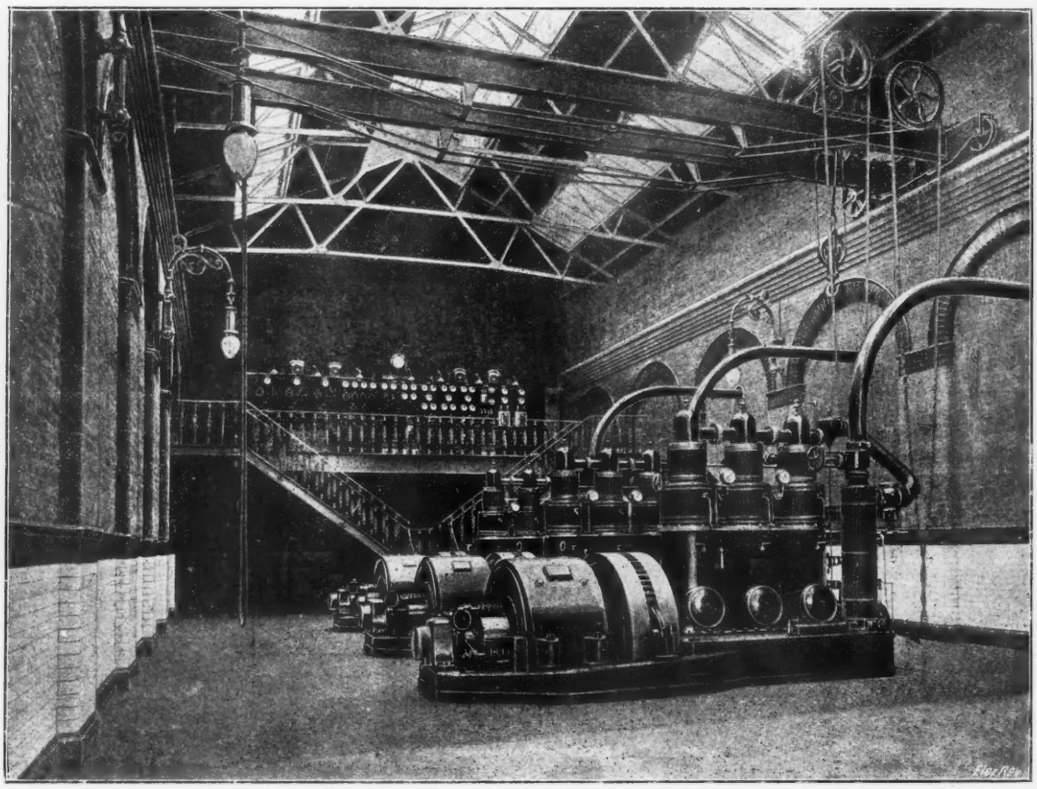
Evidently a good beginning has been made, and if the necessary funds are forthcoming as the needs of the institution increase, we may yet have a National Laboratory able to bear comparison with those of Germany and the United States.

NELSON ELECTRICITY WORKS EXTENSIONS.

The Corporation of Nelson has been an electricity supply undertaker from the year 1892, when operations were commenced with a small station erected at the gasworks. Last year, however, having obtained two light railway orders and powers to convert the tramways between Nelson and Burnley from steam to electric working, the Corporation decided to completely reorganise the system of supply. It was resolved to build an entirely new station on land adjoining the refuse destructor, and to change over from the two-wire system at 110 volts to the three-wire at 2 × 230 volts. By this means the steam from the destructor, which is of Meldrum's "Simplex" pattern, could be utilised for the traction day load, and the generating plant would be available for both traction and lighting.

Mr. W. A. Fraser, who, our readers will remember, spent a year at the front with the Middlesex Imperial Yeomanry during his tenure of the office of borough electrical engineer at Lancaster, was appointed electrical engineer to the Nelson Corporation in May last, and in conjunction with the borough surveyor, Mr. B. Ball, designed the buildings. These consist of a spacious engine room, 88 ft. × 33 ft., capable of accommodating six 200-kw. steam dynamos, and a boiler house, 63 ft. × 63 ft., providing for five Lancashire boilers, each 30 ft. × 8 ft. diameter, as well as battery, pump, and mess rooms, repairing shop, and offices for the engineer and staff. The latter are on a level with the switchboard gallery. The guiding principle followed by the engineers in the design of the buildings was to provide plenty of space round the machinery, so that all parts could easily be got at—an important provision, and one of which the value is often insufficiently appreciated, especially when an architect is employed to design the buildings.

The buildings were commenced in the middle of July last year, and were finished by the end of February last, a performance which, it is reasonably claimed, constitutes a record. The opening ceremony took place on 12th inst., as briefly noted in our columns, when Councillor W. Reed, the chairman of the Electricity Committee, formally started the machinery. Councillors Horsfall, of Brierfield, and Dyson, and the Mayor of Nelson, also took part in the proceedings, and Councillor Reed stated that the scheme was to cost about £30,000. In the evening Mr. Reed entertained the numerous guests at the Town Hall. In the course of the proceedings it was stated that Brierfield is to be supplied with electricity from Nelson for some years to come.



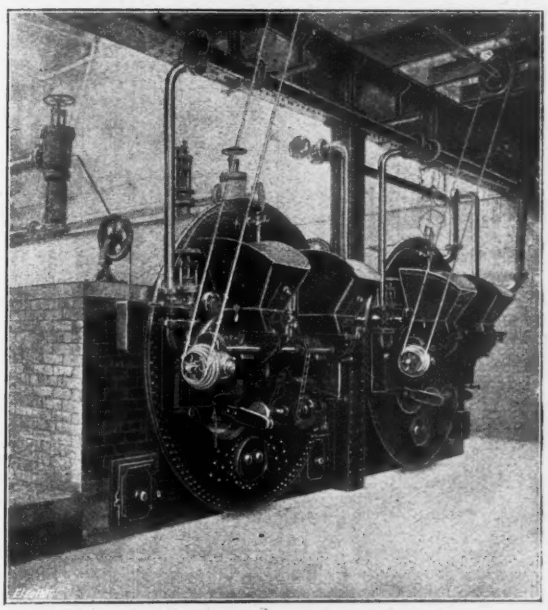
Nelson: Engine Room.

The contractors, represented by Mr. Tom Callender, presented Mr. Reed with a memento of the occasion in the shape of a gold watch and chain.

The generating plant, which is shown in the above illustration, consists of three 200-kw. steam dynamos, running at 350 revolutions per minute, with a steam pressure of

150 lbs. per sq. in. The engines are of Messrs. Willans and Robinson's three-crank type, each capable of developing 300 I.H.P., and working condensing. The dynamos are of Messrs. D. Bruce Peebles & Co.'s make, of the four-pole compound-wound traction type, and give out 400 amperes at 460—480 volts, shunt-wound, 500—550 volts compound, without moving the brushes.

The boiler plant consists of two 30 ft. × 8 ft. Lancashire boilers, supplied by Messrs. E. Danks & Co., of Oldbury, and fitted with Proctor's mechanical stokers. A Green economiser of 192 tubes is provided, and feed pumps of Messrs. G. & J. Weir's manufacture. Steam piping and condensers were supplied by Messrs. Cole, Marchent and Morley, of Bradford.



Nelson: Boilers.

A balancer-booster set of four machines coupled together, has been supplied by Messrs. Greenwood & Batley, of Leeds. Each of the balancer armatures can carry 150 amperes, and the booster armatures each give 75 amperes at 50 volts.

The lighting and traction switchboards were made by Messrs. Dorman & Smith, of Manchester, and comprise panels for three dynamo, three lighting feeders, three traction feeders, and one B. of T. panel. The gear provides for using any machine on either the lighting or traction load.

The battery consists of 268 cells made by the Tudor Accumulator Company, Limited, and is capable of giving a discharge of 137 amperes for 10 hours, or 263 for 3 hours.

The mains were supplied by Messrs. Callender's Cable Company, and are laid on the solid system in wood troughing; the total length of cable amounts to 19 miles in 6 miles of streets. Switch pillars at the feeding points provide for the connections between feeders and distributors.

In conclusion, we wish to congratulate Mr. Fraser on the successful inauguration of his new works, and to express our thanks to him for the photographs, and for the particulars upon which this article is based.

THE INDUSTRIAL FREEDOM LEAGUE.

This Association has issued a preliminary manifesto explaining the *raison d'être* for its formation and a comprehensive plan of campaign.

It is called into being by the facts proved to the Committee on Municipal Trading, which by no means completed the important work for which it was constituted.

The re-appointment of the Committee is imperatively demanded, as although it took a great deal of evidence, it was limited mainly to the electrical industry, and was by no means of an exhaustive character.

The question is of the widest nature, embracing the whole problem of municipal socialism *versus* private enterprise, involving every trade and a revolution in the industrial pursuits of the people.

The Industrial Freedom League aims at defending all trades from the rate-aided competition of municipalities, and if it gain the support of the trading community generally, it cannot but exercise a very prompt effect upon the system whose rapid growth naturally causes alarm.

Some £320,000,000 of capital, for which the ratepayers are responsible, has already been raised, and this constitutes a formidable competition with private enterprise.

It must always be kept in view, in dealing with this subject, that the ultimate goal of the municipal socialist is the abolition of all private trading, and the absorption by a labour-governed State of all land, capital, and instruments of production and trade.

This has been clearly laid down as the object of the movement, and the progress already made in the supply of water, gas, electric lighting, and tramways can have no other logical limit than that honestly admitted by the Socialist leaders as the ultimate result they desire.

We have heard it suggested that the Industrial Freedom League is intended to counteract the influence of the Incorporated Municipal Electrical Association.

The plan of campaign is upon obviously sound lines. The last item of the programme summarises the means proposed to be taken, viz., "to rouse public opinion and secure the revival of that spirit of industrial toleration to which the past commercial success of the nation was so largely due," and it is intended to accomplish this by educating the public thoroughly as to what is going on—in municipal competition with private trading—and by organising opposition by means of the formation of local ratepayers' associations.

These associations, to be effective, must absolutely ignore all party politics, and secure the election of Town Councils free from the pernicious doctrines of municipal socialism, and prepared to carry out effective local government, without risking the ratepayers' money in trading in competition with them.

Such associations will stop the mischief at the source, and if legislative action be necessary, can exercise the same important influence upon Parliament as is at present exerted by the Association of Municipal Corporations, acting through the local authorities with which they are connected.

The campaign against municipal trading has been too much in the hands of one section hitherto, viz., the electrical industry, and this has been caused, no doubt, by the pressure brought upon a special trade by the competition of municipalities which, while injuring the particular enterprise, has entailed heavy losses upon the ratepayers.

The Electrical Trade Section of the London Chamber of Commerce has therefore been able to bring about the inquiry before the Parliamentary Committee, but the interests of a new and special trade in the hands of a comparatively small community is not enough to put an end to the evil, which really affects all industries, which must combine if any effective results are to be obtained.

It is alleged that the Industrial Freedom League has already made substantial progress in securing to the movement the support of influential railway interests, which form a very important section of the ratepayers throughout the country. In the recent Local Government Board inquiry into an application for a loan for municipal electric lighting at Hendon, the Midland Railway Company opposed as ratepayers, and if all the railway companies adopted a similar course in the interest of their shareholders, and of that private enterprise of which they are such conspicuous examples, pernicious municipal trading would receive its quietus, for then local, as well as Parliamentary, influence would be sufficient to protect the country from the mistaken and ruinous action of the municipal Socialists.

The manifesto of the Industrial Freedom League quotes the utterances of many public men in support of their views, all pleading for greater liberty, greater freedom and less restraint for private enterprise. Lord Salisbury would allow "enterprise to have its full swing, and to remove the

obstacles which have still impeded it." With such views, what an ideal President he would make for the Industrial Freedom League!

THE DESIGN OF CONTINUOUS-CURRENT DYNAMOS.

By RANKIN KENNEDY.

The mistake in my previous article on this subject is obviously a slip of the pen. *Ampere-turns*, as pointed out by Mr. Aubrey Clayton, is the proper term to use. The ratio of armature winding to field winding, must, of course, be given in ampere-turns. However, while Mr. Clayton puts the matter very clearly, he still leaves an important point untouched.

There is a hiatus in the process for designing dynamos which no one has as yet filled up. It is hinted at in Mr. Clayton's article, where he says: "Most designers have some rule or other to go by, in most cases one based on their own experience, which guides them to the right proportioning of field strength to armature strength."

I shall quote another designer on this point, an eminent one too:—"The determination of the best diameter and length of armature core without reference to other designs or machines previously built can only be effected by a method of trial and error." If this sentence means anything, it means that there are no formulæ for calculating out an armature for a given output at a given speed.

Yet another expert, in tackling the design of dynamos, takes as a starting point 2·5 per cent. of the output in watts as the external surface of the armature; thus for a 25-KW. machine 625 sq. in. would be the surface — a mere empirical rule.*

The fundamental formula is as follows:—

Let E = E.M.F.
Z = Total flux through armature.
N = Speed in revolutions per second.
t = Number of turns of wire on armature.
C = Maximum current output.

Then $E = ZNt$.

And the dimensions of the armature must be governed by the value of Z and t and the current at maximum output.

$t \times C$ should have a certain ratio to Z to get sparkless collection, and this is where the hiatus comes in. Both Z and t are unknown quantities; their value is, in any design, left to the judgment and experience of the designer.

In all my experience with dynamos the ratio of Z to $t \times C$ is the determining factor in the design of a sparkless dynamo with fixed brushes, and from all the best dynamo designs it should surely be possible to arrive at some value for Z, at some speed and output, from which a general formula for Z could be drawn, whereby, given the speed and output of a machine, Z could at once be calculated. This value found, all the rest follows. If instead of calculating out results on a rule, obviously mistaken, Mr. Clayton had worked out a series of calculations from first-class designs to find the ratio of

$$\frac{\text{Field ampere-turns for gap and teeth}}{\text{Armature ampere-turns}},$$

we might get some idea as to the value of Z per KW. at some known speed.

But it would be better still to find the value of $\frac{Z}{t \times C}$ for a number of first-class machines of various outputs.

In my opinion, the saturation or non-saturation of teeth is a matter of no import; a high strength of armature compared with the field is just as vicious with armatures in which there are no teeth at all. A machine of this class, which sparked badly, fell into my hands some years ago. A plain drum armature, with four layers of wire winding on it, was completely cured by making a new armature core and re-winding with half the number of turns of wire on the armature, reducing the air gaps by nearly half, and slightly increasing the speed.

Whatever may be the theories regarding commutation, there is no getting away from the practical fact that where Z is low compared with $t \times C$ the machine is bad, and where Z is high compared with $t \times C$ the machine is a good one, and what is wanting in dynamo design is to find just what the ratio should be between these two factors. This found, there would be no more of these humiliating admissions which I have quoted.

Of course, the question of cost comes in and explains the persistence in high armature strength; it makes a cheaper machine, and that seems to be the chief consideration with some designers. In Mr. Clayton's instance, he improved a machine by reducing the field magnet and increasing the armature diameter. But he does not say what the ratios of strengths were before and after the transformation.

* See also Kapp's "Dynamos, Alternators and Transformers," pages 288 to 290:—"The condition of sparkless collection is that B_a shall be above a certain limit. *Authorities differ what this limit should be.*" "The best modern practice is to keep the reversing field fairly strong, say, 2,000 C.G.S. lines."

THE EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY, LIMITED, v. CAPE TOWN TRAMWAY COMPANIES, LIMITED.

[By a Legal Contributor.]

It appears probable that the long-standing dispute between electric tramway companies and telegraph and telephone companies respecting the right of the former to use uninsulated tram rails as their return conductor, will be settled finally by the decision of the Judicial Committee of the Privy Council in an appeal in the above action argued before them several weeks ago, and now awaiting judgment.

A few words will serve to call to mind the history of this dispute. When the telegraph system was introduced in this country in 1837, the simplicity and economy of using an earth return at once recommended itself, and an earth return was universally adopted, and when, in the course of time, telephones made their appearance, earth returns were commonly used in their case also. (The Post Office telephones had, in many cases, a complete metallic circuit.) Any interference between these circuits, due to leakage or induction, was negligible, on account of the minuteness of the currents used—about $\frac{1}{10}$th of an ampere in telegraph circuits, and perhaps the hundredth part of that in telephone circuits.

All such companies and undertakings, therefore, used the earth for their returns, in harmony, and with a sense of security which was not justified by events. For when about the year 1889 the construction of electric tramways in the country was commenced, and the tramway companies claimed the right to use their uninsulated rails as a return for their large currents, the conditions of the problem were entirely altered. The telegraph and telephone companies, together with railway companies using telegraphic communication, contended that tramway companies should be compelled to use closed circuits. They argued, with some force, that no class had a right to monopolise the earth, and that the heavy currents used by tramways must necessarily exclude themselves from continued use of the earth, and that although they were in possession of the field first. In consequence of these representations, in the majority of Bills and orders seeking powers of electric traction a protective clause was inserted, usually modelled upon the clause inserted in the Plymouth Tramway Bill, binding the company to so work their tramways as to prevent any injurious interference with telephone and telegraph circuits. These protective clauses were adopted, because it was supposed that while tramway companies would be liable at common law for any damage resulting from disturbance caused by their currents, yet tramways authorised by the Legislature would be protected from this common-law liability provided always they were laid and maintained with proper skill and care, and without negligence. This view of the law was confirmed by the decision of Mr. Justice Kekewich in the case of the National Telephone Company *v.* Baker, in 1893.

The increasing number, however, of electric tramways in this country, their great convenience to the public and the

expense caused to the tramway companies by compelling them to use a closed circuit, induced the Legislature in 1893 to appoint a joint committee, of which Lord Cross was chairman, to consider the questions and interests involved. A number of eminent men of science were examined before the committee, and great efforts were made by the telephone companies to retain the protective clauses. The committee, however, adopting the view that "roads were made to walk on, not to talk on," reported, "It is not in the present state of electrical science to the interest of the public to insist upon electric tramways providing an insulated return conductor, and that such obligation would retard the development of electric traction." This was coupled with a recommendation that telephone and telegraph companies should use an insulated return parallel to or twisted round the outgoing wire, which precaution, it was proved to the Committee, was a complete protection against all external interference.

But though victory lay with the tramways, so far as statutory authority is concerned, yet it has always been held, up to the present time, that a common law action would lie against any tramway company not authorised by statute or provisional order for all damage due to electric disturbance caused by its current, and that an injunction could be obtained restraining such disturbance.

To return to the appeal now before the Privy Council; this action was brought by the plaintiffs, the Eastern and South African Telegraph Company, Limited, who maintain, among other cables, that known as the West Coast Cable, which passes down the West Coast of Africa, and lands in Cape Town, against the defendants, the Cape Town Tramway Companies, Limited, who maintain a system of electric tramways in Cape Town and its suburbs, for damages resulting from disturbance of the plaintiffs' cable, and for an injunction.

The relative positions of the tramway lines and the cable were shown in papers prepared by Mr. Trotter and Prof. A. Jamieson (see ELECTRICAL REVIEW, Vol. xl., May 14th, 1897, and Vol. xlvi., 23rd, 1900). The tramway companies obtained statutory authority to lay and maintain all their lines, with the exception of the section of about a mile and a half of line. This section was laid down and maintained without statutory authority, though with the permission of the road authority. The tramway current is conveyed from the generating station by means of overhead wires, and returns by the uninsulated rails. The cable lands at the cable hut, whence communication is established by insulated land wires with an office in the Standard Bank Building. The tramways commenced running in August, 1896, but at that time only the section between the Standard Bank and Mowbray Cemetery was working. Immediately the cars began to run, it became difficult to read cable messages received in Cape Town, and the disturbance soon became so severe, that the greater part of the receiving work had to be done at night when the cars had stopped, while it was necessary to divert a portion of the traffic to the East Coast Cable.

Mr. D. Wilkinson was employed by the plaintiffs to investigate the cause and nature of the disturbance, the defendants doing everything in their power to assist him. The result of Mr. Wilkinson's tests carried on during a period of several months was to make it clear that a portion of the tramway return current escaping from the rails found its way to the sheathing of the cable along which it travelled towards the generating station, and that the variations in this return current, as the cars stopped and started, were the cause of induction currents in the core of the cable. It was found that when the sheathing of the cable was connected to the sheathing of the land lines in the cable hut, currents of varying intensity passed between them, sometimes from the cable to the landlines and sometimes in the reverse direction; these currents were of such strength as to ring a bell loudly, and to cause sparks to pass on making or breaking connection; on measurement they were found to frequently reach 5 amperes, and sometimes to exceed that. Mr. Wilkinson found that the fall of potential along the rails from the Wynberg terminus to the generating station was some 25 to 30 volts, and that nearly 30 per cent. of the return current escaped from the rails. It was the working of this section of the line (about 7 miles in length) which caused the greater part of the disturbance. The fall of potential on the Sea Point section sometimes reached 16 volts; but these potentials were afterwards somewhat reduced by the employment of boosters with return feeders. Mr. Wilkinson remarks that the low-lying marshy ground of the Cape flats between the tramway lines and the sea is probably a good conductor for the escaping current.

Various experiments were tried by the cable company with a view of overcoming the disturbance, and a number of different earths for the cable return current were tried, but without success. At length, in January, 1897, a return cable, 5 miles long, was laid in Table Bay, as nearly as possible parallel to the main cable, the end of the copper core of the return cable being connected to the sheathing of the main cable, so that "earth" was made 5 miles out at sea. The disturbance immediately decreased, and for a time practically disappeared. After a few months, however, it commenced to increase again, and it was contended that this was due to an extension of the tramway system. In May, 1898, a second return cable, 10 miles in length, was laid (afterwards extended to Robben Island), and traffic has since been carried on by its use, though it is said that even now it is difficult to obtain a satisfactory duplex balance.

In April, 1899, the plaintiffs commenced their action, claiming an injunction, and £50,000 as damages for loss of business and estimated expenditure necessary to completely cure the disturbance. The plaintiffs contended that the damage they complained of was covered by the following section in the statutes authorising the construction of the defendants' tramways: "The company specially undertakes that, in the event of any electric leak taking place, and damage being thereby caused at any time by electrolysis or otherwise, it will reimburse and make good to the Council or other body or person all costs to which the Council or other body or person may be put by reason thereof, &c." The plaintiffs also contended that as regards the section of line for which statutory authority had not been obtained, the defendants were liable at common law upon the principle established in the case of Fletcher *v.* Rylands (L.R., 3 H.L., 330). In this case the House of Lords held that a person who brings on his land and collects and keeps there anything liable to do mischief if it escapes must keep it at his peril, and if he does not do so is *prima facie* answerable for all damage which is the natural consequence of its escape.

The defendants contended (1) that the escape of electricity from uninsulated rails was not an "electric leak" within the meaning of the section; (2) That the damage caused to the plaintiffs was not damage caused by "electrolysis or otherwise," inasmuch as the words "or otherwise" were intended to cover only things *ejusdem generis* with electrolysis; (3) that they were not liable in respect of the unauthorised section of line, as they had not infringed any legal right of the plaintiffs known to the law of the Colony of the Cape of Good Hope.

After some evidence had been taken on commission in London, the action was tried in Cape Town before the Supreme Court of the Colony in February and March, 1900. The principal witness for the defendants was Mr. Frank Jacob, who went out to Cape Town for the purpose. Mr. Jacob, speaking from a wide experience of submarine cables, said that if the plaintiffs as soon as the disturbance commenced had laid a twin core shore end cable two miles out to sea, and had there connected it with the main cable, they would at once have completely cured all disturbance; that this was the only permanent remedy; and that it was the practice to attach twin core shore ends to modern cables as soon as they were laid down.

It was explained that a twin core shore end consists of two cores insulated from one another and contained within the same sheathing; the end of one core is connected to the core of the main cable, while the second core is connected to the sheathing of the main cable. The cable is thus earthed out at sea, while any stray currents travelling along the sheathing of the shore end will induce precisely equal currents in the two cores, which, on arriving at the recording instrument, will neutralise one another. Mr. Jacob was of opinion that two miles would be ample in the present case. The five-mile and ten-mile return cables were not complete remedies, because they could not be laid precisely parallel to

the main cable, and, moreover, were liable to shift their positions. The plaintiffs now admit that a twin-coil shore end is the proper remedy, and propose to lay one down as soon as possible.

The Supreme Court found for the defendants upon all points: that the escape of current from the rails was not an "electric leak," and that the damage caused was not damage caused by "electrolysis or otherwise" within the meaning of the section; *and that as regards the unauthorised section of line, the construction and working of it in a proper manner and without negligence was not an infringement of any legal right of the plaintiffs.*

The plaintiffs appealed to the Judicial Committee of the Privy Council, before whom the case was lately argued and now awaits judgment.

The decision of the Judicial Committee will not, of course, be binding upon the Courts of this country, but there can be little doubt that they will follow it.

CORRESPONDENCE.

Overhead Mains.

Some months since you expressed some interest in the question of overhead mains, and invited opinions from engineers thereon.

I quite agree with what you said on this matter, chiefly to the effect that for small towns this method of distribution was economically essential, and that it was, moreover, perfectly satisfactory in respect both of safety and reliability. Such has been my experience to the letter in Durban. Though I have laid down in the business portion of the town some eight miles of low tension distributors, I recognised when extensions into the residential districts were considered that underground mains would not pay—Durban, like most Colonial towns, being one of magnificent distances. I therefore determined to depart from the practice I had been accustomed to in England, and have in the past two years put up 30 miles of pole line for low tension distribution, though the high tension mains are all underground. By the use of these (paper) high tension mains, transformers in neat street boxes above ground (looking similar to tramway feeder boxes, now become familiar in England), and low tension overhead distributors, it is possible to supply current in scattered residential districts without involving very high capital charges.

And especially is this the case when street lighting by means of incandescent lamps can be added. This form of lighting on country roads with plenty of trees is generally cheaper and more efficient than by means of arc lamps. The revenue from this source is sufficient to pay the capital charges on the low tension pole lines, leaving private lighting with only transformers and small high tension cables against it. I send photo. of a pole line with incandescent lamps fixed, and also one of a street transformer box. These boxes have given complete satisfaction, though certain modifications are necessary in the present form of switch gear. Underground brick chambers are quite too expensive, and the underground iron box is not very accessible. It is possible to design safer and more get-at-able switchgear in a box of the above-ground pattern. This is especially important in Colonial work. The size of box shown will accommodate a 20-KW. transformer. In a very scattered residential district this is a sufficient amount of power to distribute from one point, though I am increasing some of mine to 30 KW.

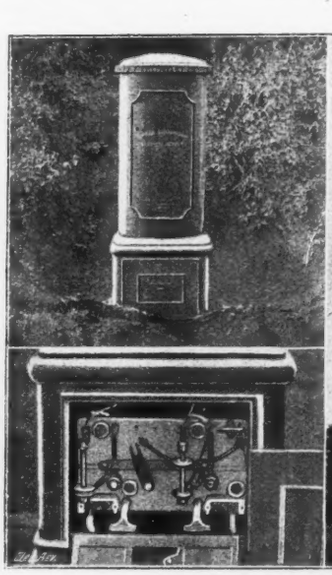
The system is, of course, single-phase high tension, which, in the absence of any considerable demand for motor power, is by far the best, in my opinion, where long distances have to be covered. We, in Durban, go out five miles in two directions.

I have recently advised the Ladysmith Town Council on a lighting scheme, and enclose a copy of my report to it. The distances being comparatively small, I have recommended continuous current, and the report represents what, from my experience, is the best way to equip a small town with a paying electric lighting plant.

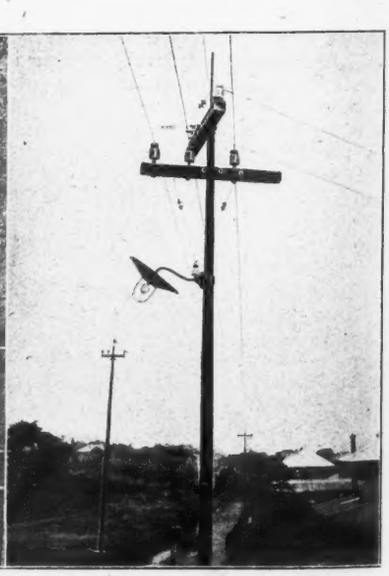
John Roberts.

Borough Electrical Engineer's Office,
Durban, Natal.
February 21st, 1902.

[We reproduce the photographs herewith, and have examined the report with much interest. Mr. Roberts recommends direct current, distributed by mains entirely overhead, of hard-drawn bare copper on neat iron poles. The capital expenditure for a system to supply 250 consumers is put at £8,500, 100 16-C.P. lamps being also used for street lighting.—EDS. ELEC. REV.]



TRANSFORMER BOX. BASE OF DO.



OVERHEAD MAINS.

Corporation Tramways and Emergency Brakes.

Just recently one or two large Corporations have placed orders for emergency brakes for their tramcars; this is a wise move, for, by adopting an efficient emergency brake (which will act under all and every condition of circumstance), many accidents will be prevented, and the consequent list of deaths, injuries, mutilated bodies and lawsuit damages and legal expenses due to tramway accidents will, to a very large extent, be avoided. The conditions which an emergency brake should fulfil are:—

1. It should be possible, under all circumstances, to apply the brake instantaneously, whether on the level or on the incline.

2. It should be operated so simply as to require little or no effort on the part of the motorman.

3. It should act on the rails, and not on the wheels, because, when the wheels get locked and skid over the rails (which they very frequently do when the rails are wet, or when going down an incline), such wheel brakes become practically useless.

4. While an emergency brake should be capable of being instantaneously applied with great power, yet at the same time its sudden application should not be accompanied by a violent jolting of the car, which would uncomfortably shake the passengers, and be detrimental to the car itself.

While my object is not to criticise electro-magnetic brakes, still, the fact must not be lost sight of that their action

depends upon a current of electricity generated from some source; and we all know that it is very easy for there to be an interrupted or broken circuit somewhere, also that it is not impossible for a motor armature to burn out, or the field magnets to fail to excite from some cause, in which case such electro-magnetic brakes become useless; the ideal emergency brake is one whose action is independent of the electrical circuit. I have had occasion to investigate the subject of emergency brakes, and the one such brake which gave ideally satisfactory results was the pneumatic track brake; this brake, I believe, is the invention of Messrs. Hewitt & Rhodes, consulting tramway engineers, of Manchester. Its chief features are that it is simple and positive in its action, it acts under all conditions, it is very powerful, and does its work instantly and efficiently. Its action is entirely independent of the electrical circuit; it is constructed on well-known mechanical principles, and is strongly made. There is no part of it which is liable to get out of order, and while acting so powerfully and positively, still at the same time it does not violently jolt the car. This I attribute to the fact that the air in the cylinder forms a pneumatic cushion which takes up most of the jolts and vibrations instead of them being transmitted through the framework of the car itself. It would not be time wasted for tramway engineers and corporations to investigate this brake, and it would be a good idea if the Board of Trade made it imperative that efficient emergency brakes be adopted by all tramway corporations and companies.

Wm. R. Bowker.

Technical Terminology.

The article on "Technical Terminology" in your issue of February 14th, and the letter and your comments thereon in the issue of February 21st, were of considerable interest. Undoubtedly there is great want of care on the part of writers and others in avoiding the mis- and ambiguous use of terms; and considering the rate at which new terms become necessary and are introduced, we are in some danger of getting into an inextricable muddle. Really, the matter is important enough for a well-selected Committee of the Institution of Electrical Engineers to take in hand.

As regards the question of frequency, perhaps I may be permitted to quote a passage from my "Alternating Current Circuit," in which I took some pains to put the matter, as I hope, clearly and concisely.

Referring to the revolution of a simple coil in a simple two-pole field, this is what I say:—

> If the coil is connected up with an outer circuit, in one revolution the induced E.M.F. and resulting current will make two *alternations*, or one complete *period* or *cycle*; and the *rate of double alternations per second*, or *number of complete periods* or *cycles per second*, which is termed the *frequency* or *periodicity*, will depend upon the number of revolutions which the coil makes in that time. Thus, supposing it revolves 600 times in one minute, the frequency of the E.M.F. and of the current set up will be 10.
>
> Frequency is denoted by the symbol ~, thus 70 ~ signifies a pressure or current making 70 complete periods per second—*i.e.*, having a frequency of 70.
>
> The frequency of alternating currents, as used for ordinary work in this country, varies from 40 ~ to 130 ~, the present tendency in central station work being to reduce it to something like 50 ~ or 60 ~. For special purposes, E.M.F.'s of very much higher frequency are sometimes employed.
>
> The rise and fall of the current in *one* direction should be called an *alternation*; but this term is sometimes employed to indicate a complete reversal—*i.e.*, a *period* or *cycle*, a disagreement which is somewhat confusing. Referring to fig. 31, the portion of the curve from 0 to 180 is really an alternation, and the portion from 0 to 360 a cycle or period, and the symbol for frequency (~), being derived from the shape of the curve, should assist the student in remembering this. An *alternation* is, as its name indicates, an alternative wave or alteration in direction. Thus a frequency of 80 ~ means 80 periods, or 160 alternations, per second.

I should be glad to know if this is sufficiently explicit. Speaking still of alternating currents, it may be mentioned that the difference between virtual and effective quantities is not too well understood by the average engineer. The *virtual pressure* is that impressed on the circuit, but if reactance is present, only a part of this will be *effective* in setting up a current—*effective pressure*. The current, as measured by an ammeter is *virtual*, but depending on the phase difference only a portion of it may be *effective* in doing work. *Virtual resistance*, otherwise impedance, is the combined effect of the ohmic and spurious resistance (reactance) in a circuit.

Inductance is a term (uniform with *resistance*, *conductance*, *reactance*, and *impedance*) which merits much more general use; and its hard-worked relative, *induction*, should never be employed in electrostatic cases. *Influence* should long ago have superseded *electrostatic induction*, and we should speak of *influenced charges*. We have *influence electrical machines*, though some people still prefer to term them *induction machines*. Why do those ancient terms *galvanic* and *voltaic* remain in use? Why *voltaic arc?* And why in some important article or paper which I read the other day was the misspelt word *loadstone* to be found?

W. Perren Maycock.

500-Volt Electric Shocks.

May I briefly add my experience *re* the above. When I was depôt foreman on the Waterloo and City Railway, I, on three occasions, received a severe shock from a defective automatic cut-out. Each time there was a vivid flash, with the result that one of my hands was badly burnt, the hand making the least perfect contact. I have the resultant scars to show.

My predecessor also received a bad shock and burn from the same cut-out, which put his hand out of action for a great many weeks. I could give several other instances with the same results.

I assure Mr. Trotter that it would be a very dangerous proceeding on his part to sit on the rail and touch the live conductor with his finger. On a wet day I have received a severe shock *by just touching the conductor with my wet boot, when standing on a wet sleeper* (*wooden*), let alone the rail.

Albert E. Vezey, A.M.I.M.E.

London, *March 21st*, 1902.

With regard to the paper read before the Institution of Electrical Engineers by Mr. Trotter, and your remarks thereon in last week's Review, it appears to me that the substitution of the battery in place of the compound-wound generator would, owing, as stated in your remarks, to the internal resistance, and also that of the body, prevent an excessive current passing, and, at the same time, materially decrease the voltage of same, and the longer the battery was thus shorted the less dangerous would it become; on the other hand, moreover, the compound machine would lose neither voltage nor current, but would keep up a constant current at a constant pressure. The danger lies not so much in the fact of being able to get high *voltage* shocks, but of getting also large currents flowing at these pressures. Again, the resistance of the body varies, and the experiments would have been, as far as my own experience goes, considerably more interesting had they been carried out in the height of summer, when the resistance of the body is at its lowest.

I should also like to add, like the Review, I used to endeavour to make light of electric shocks, especially at what are practically low voltages; but last summer, when I accidentally shorted the secondary of a transformer, whose normal voltage was 220, through my body, I was rendered unconscious in a very short time, and the current passing through my body was of such a strength as blow a No. 22 copper fuse; this undoubtedly proves that the resistance in circuit must have been very low, and here, I think, is an instance where the chances of serious injury from a less voltage than 500 should be fully recognised. Although the voltage undoubtedly rose considerably above the normal (*i.e.*, 220), I question if it reached anything like 500; and the difference between alternate and direct current shocks cannot be lightly passed over.

The recent death at the "Alhambra," Sheffield, seems to suggest that the shock was obtained by the earthing of the unfused pole through the body of the victim, when the current passing would then be limited to the capacity of the

main fuse; and assuming the earth resistance low, the current passing might be considerable, otherwise it is difficult to see, if the lamp fuse was of correct dimensions to carry from about half to three amperes, how this accident happened, if, as stated, the shock was received from both poles, and not through earthing one conductor only.

W. F. Stamp.

London, *March 20th*, 1902.

Polyphase Working.

In looking over the Howard Lectures delivered last May on "Polyphase Working," by Mr. A. C. Eborall, I find on p. 39, Lecture III., the sentence "Transformers supplying current to rotary converters (which are never paralleled on the three-phase side) should always be," &c. If you will kindly explain what is meant by "Never paralleled on the three-phase side" I should feel much obliged, as I have always understood that what is meant by paralleling alternate current machines is to run them up to synchronism and synchronise them; as far as I can understand the sentence in question, Mr. Eborall means that the machine is run up with the generator, or else plugged on to the bus bars at any time like an induction motor, trusting to good luck for the volts coming up on the D.C. side first time. If the construction I put on it is right, it is rather a misleading statement.

Foggy.

[Our correspondent regards "synchronising" as identical with "paralleling," whereas they really need have nothing to do with each other. Direct-current dynamos are paralleled, but not synchronised, while (synchronous) alternate-current motors are synchronised, but need not be paralleled. In this case, the rotaries are, of course, synchronised in the best practice; but they are not usually connected direct to common bus bars. The common connection (or paralleling) takes place on the high pressure side of the transformers only, each rotary with its set of transformers being treated as a separate unit.—Eds. Elec. Rev.]

The Testing and Management of Electric Motors.

I am afraid that Mr. Dix has not given close attention to the contributions which he finds so entertaining. Had he done so, it would not be necessary for me to remind him that from the equation—

$$w = \mathrm{E\,C} - \mathrm{C^2\,R}$$

can be deduced, by a simple process, the remarkable equation which he ascribes to Mr. Poole. Let the above equation be written in the following form—

$$\mathrm{C^2\,R} - \mathrm{E\,C} + w = 0$$

(w = work per second)

and solved as an ordinary quadratic equation in which C is the unknown quantity.

It may be of interest to follow the argument further, and find what value of C will give to w *(the work done by motor in unit time)* its greatest value. This process can be made to involve the calculus—the loss of which on my part seems to give considerable concern to Mr. Poole. Mr. Dix may now see what I meant by asking the apparently ridiculous question: What is represented by the figure (numeral, or integer) in—

$$4\,r\,(\mathrm{W} + w)\ ?$$

P. T. White.

The Harburg I.R.C. Company and Ferd. Winter v. Browne Martin.

Allow me to point out that your report of this appeal case in your issue of 21st inst. is incorrect, in so far as the name of defendant is quoted as Martin Brown instead of *Browne Martin*, an error which had crept even into the official list of cases, but which should be corrected, so that everyone may get his due.

Naturally, I bow to the judgment of the Appeal Court. The judges undoubtedly have to apply and interpret the law as it stands. In this case a jury and Mr. Justice Mathew have found, and so did the three judges sitting on the appeal, that defendant gave, before a witness, a definite "*promise that he would give bills for the amount of the judgment debt*" (quoting your own report of this appeal case), bills endorsed by himself, he being the controlling power of the syndicate concerned, and by his brother, the debenture holder.

I hope the fact commends itself to the commercial world that *four of his Majesty's Judges find a certain promise was given*, and that three of them find that *it need not be kept because it was not given in writing*, and, therefore, the defendant may claim, as he did claim, the protection of the ancient Statute of Frauds.

This, then, is the law. Is it justice as well?

Ferd. Winter.

London, *March 3rd*, 1902.

LEGAL.

The Finchley Electric Light Company, Limited, v. The Finchley Urban District Council.

This case came before Mr. Justice Farwell in the Chancery Division on Monday and Tuesday last week. Mr. C. Jenkins, K.C., and Mr. Buckmaster appeared for the plaintiffs; and Mr. W. H. Upjohn, K.C., and Mr. Chubb for the defendants.

Mr. Buckmaster said that the case raised an important question. The plaintiff company sought an injunction to restrain the defendants from cutting their wires that stretched across the roads that were within the area of the Urban District Council. The facts were these:—The plaintiff company was incorporated under the Companies' Acts, and formed for the purpose of supplying electric light and power. The plaintiff company had no provisional order from the Board of Trade, and had no sanction whatever from any authority. It was simply a private trading company acting under the powers conferred by the Companies' Acts. It appeared that defendants in 1898 obtained a provisional order from the Board of Trade enabling them to supply electricity to the inhabitants of their district—an order which, when the plaintiff company began to work, the defendants had wholly failed to act under. The plaintiff company was incorporated in 1899, and immediately after its incorporation it set to work to supply electric light to the inhabitants of the district. One of the first things they did was to lay mains down Cavendish and Stanhope Avenues which were private roads not vested in the defendants. The plaintiffs laid the mains down the footpaths adjoining the roads instead of down the middle of the roads. Having done this, they were met at once by the defendants who said that they declined to take over any of these roads if the mains were laid in that way. They insisted on the plaintiffs laying the mains down the middle of the roads. That was an extraordinary objection, but the reason was that the defendants desired when opportunity arose to avail themselves of the footpaths. What the defendants did was to treat the plaintiff company as rival traders, and they did all they could to hinder their enterprise. The plaintiffs also claimed damages from the defendants. After this question had arisen with regard to the private roads, the plaintiffs were in a difficult position. They had to cross a road within the jurisdiction of the defendants, and without the consent of the defendants the plaintiffs could not open roads without the consent of the Council. What plaintiffs did on one occasion was this: they obtained a license to open a road for the purpose of laying a water pipe and the water pipe was laid, but while it was being laid the plaintiffs also laid the electric main. This appeared to aggravate the defendants, because when once the main was laid they could do nothing. The defendants then commenced proceedings against the plaintiffs to restrain them from opening any road in the defendants' jurisdiction without giving notice to the defendants, and a motion was made in that matter asking for the relief. That case was settled on the terms that the plaintiffs should give notice before seeking to break open the roads, and each party paid their own costs. The provision introduced into those terms was that the plaintiffs should give notice to the defendants before they proceeded to break up the roads, so that the defendants might grant the leave, but that the defendants did not, it appeared, intend to do. The result was that the defendants were paralysed in carrying on their business. Last September the plaintiffs wished to supply a customer by carrying a wire across the Regent's Park Road. The defendants objected, and gave notice that if any wire was placed above ground or across any street without the consent of the Council they would have the wire removed. The defendants evidently thought that the plaintiff company derived its powers under the Electric Lighting Act (1888), but the plaintiffs did not derive any of their powers from this statute at all. Therefore the wire was stretched across the road, and in due course the customer would have been served with the light; but the defendants on October 1st had the wire cut in two, and threatened to do the same thing to any other wires which were stretched across any other road in their jurisdiction. The result was the present action. A motion was made by plaintiffs towards the end of the Long Vacation before the Lord Chief Justice to restrain the defendants

cutting this wire or any other wires across the roads in the defendants' jurisdiction till the trial. That motion was resisted by the defendants on the ground that the statute of 1888 gave the defendants the right to prevent the crossing of the roads by plaintiffs' wires; but this defence failed, and the learned judge granted the injunction till the trial. The pleadings were then delivered, and the defendants then asserted for the first time the position that the road across which this wire was stretched was a road, the fee simple of which was vested in them. If that were the case, the plaintiffs would be at once defeated, because the reason why they could carry their wires across a road vested in the Council was because the soil was not vested in the Council. The dispute in this case turned on the question as to the ownership in fee simple of the Regent's Park Road. The defendants asserted that the fee simple of that road was vested in them as being the road authority for the time being having jurisdiction over it, and by virtue of divers public statutes. The onus of proving that they were the owners in fee of the soil rested on the defendants; *primâ facie* the soil was not vested in the defendants at all. The learned counsel said he should leave it to the defendants to establish how they made their title out.

Mr. Upjohn, K.C., argued that the freehold of the street in question belonged to the defendants, and cited a number of public statutes dating from the seventeenth century as well as calling the attention of the Court to a large number of ancient documents in support of his contention. He submitted that the defendants had a right to prohibit the plaintiffs taking their wires across the street.

His Lordship, after dealing at some length with the points of law involved, said that under the circumstances he must hold that the land in question was acquired and was still required for the purposes of a street, and the plaintiffs, therefore, have no right to take their wires across that portion of the atmosphere above the piece of land which belonged to the defendant Council, therefore the application for the injunction with respect of that piece of land fell to the ground, but under the circumstances of the claim put forward, and the fact that an injunction was obtained by the plaintiffs against the defendants, he thought the justice of the case would be met by directing that there should be no costs. He ordered the action to be dismissed without costs.

Poole and District Electric Traction Company *v.* the Bournemouth Corporation.

Before Mr. Justice Swinfen Eady, in the Chancery Division, on Friday, Mr. Warmington moved in this case for an injunction to restrain the Corporation from commencing or continuing to construct a portion of a tramway authorised by the Bournemouth Corporation Tramways Order of 1900 between the commencement of tramway No. 2 and the point at which it crossed the boundary of the Borough of Bournemouth. The plaintiffs' case was that the Corporation's power to construct the tramway had ceased, or alternatively that before constructing it there must be an agreement between the parties as to the mode of traction to be adopted. There was no such agreement; the Corporation had not even asked for one, and if they proceeded to lay down a system different to that of the plaintiffs, they (the plaintiffs) would be put to the trouble and expense of taking it up and laying down their own system. The Corporation contended that they had an unrestricted right to proceed with the line, and the question to be decided by the Court was one of the construction of the provisional orders granted to the Corporation and the Traction Company respectively.

His Lordship said the action would be heard early next sittings. He saw no ground of urgency and made no order.

Islington Borough Council *v.* Gas Light and Coke Company.

At the Clerkenwell County Court on 20th inst., before Judge Edge, plaintiffs sought to recover £13 18s. 6d. from defendants, as compensation for damage done to their electric lighting boxes and main in Highbury Park on October 8th last, an explosion being the stated cause. Evidence was given by Mr. Albert Gay, chief electrical engineer, Mr. C. H. Yeaman, assistant electrical engineer to the Borough Council, and others for the plaintiffs; also by the distributing engineer to the Gas Light and Coke Company (Mr. Foulger) for the defendants. He stated that such a claim had never before been made against his company. The hearing was subsequently adjourned. We shall deal with the case later.

PARLIAMENTARY.

Manchester and Salford Tramways.

On Tuesday last week, on the resumption of the proceedings, Mr. Pember said both parties felt that the Bury Old Road route stood outside the general question of a general interchange of traffic on the two systems, and it had been agreed that Manchester, who already possessed powers in regard to certain portions of the Bury Old Road, should complete that route, whilst Salford should have running powers over it from a convenient junction. All disputes might be referred to the Board of Trade. It was asked that this clause should be inserted in either of the Bills. As to all the other questions, they had been settled by the agreement arrived at on Monday.

Mr. Freeman agreed with Mr. Pember's statement, and said he had agreed to take from the Salford Bill the powers for the independent lines which they had put in, in order to preserve their access.

Mr. Forbes Lankester claimed that the Stretford District Council and the other local authorities ought to be parties to any agreements between the two Corporations, and should have a *locus standi* when any matters were referred to the Board of Trade.

Mr. Pember strongly opposed any such power being given. He pointed out that the outlying authorities had leased the tramways in their respective districts to one or other of the Corporations for 21 years. If the power asked for was given, it would mean 13 or 14 different authorities squabbling before the Board of Trade.

The Committee refused the power asked for.

Consideration was then given to other clauses in the Salford Bill not dealing with tramway matters, and evidence was also given with respect to the proposals for some new lines of tramway by the Manchester Corporation which were not opposed.

On Thursday last week the Select Committee further considered the clauses, and it was stated that the following clauses had been agreed upon between the two parties:—"(1) The Salford Corporation shall be entitled at any time after the passing of this Act to make a junction between the existing tramways in Bury Old Road and the tramway No. 1 by this Act authorised at such point as may be agreed on between the two Corporations, or, in default of agreement, as shall be settled by the Board of Trade. (2) The Manchester Corporation shall, so far as they lawfully can, connect the tramways of the Manchester Corporation in Bury Old Road with any tramways which may be constructed by or on behalf of the Urban District Council of Prestwich in that road. (3) The Salford Corporation may run over, and use with their engines, motors, cars, carriages, officers, and servants, so much of the existing and authorised tramways in Bury Old Road as is situate between the said points of junction of tramway No. 1 with these tramways, and their termination at the boundary between Salford and the Urban District of Prestwich upon such terms and conditions as may be agreed upon between the two Corporations, or in default of agreement as may be settled by the Board of Trade. (4) The Salford Corporation may demand and take upon and in respect of the tramways, so run over and used by them, the tolls, rates, and charges which the Manchester Corporation are entitled to demand and take in respect thereof. (5) The Manchester Corporation shall afford to the Salford Corporation all reasonable facilities for the exercise of the before-mentioned powers."

The Committee then ordered the Manchester Bill which deals only with powers to construct tramways to be reported to the House. The clauses in the Salford Bill referring to police and sanitary matters will be considered by another committee on April 16th.

Liverpool and Manchester Electric Railway Bill.

On Tuesday last week a Select Committee of the House of Commons, presided over by Col. Bowles, considered the Manchester and Liverpool Electric Railway Bill.

Mr. Moon, who represented the promoters, said it was sought to make a deviation from a portion of the route agreed to last session in Salford, and the Bill was really for the purpose of carrying out an agreement with Salford made last year, when the Bill was before Committee. One of the features of the scheme was that there should be an incline at the commencement of the railway, with the object of getting up speed more quickly when a train was going down, and of lessening the speed when it was going up. It was first proposed to cross Salford by means of a viaduct, and afterwards by means of a cutting; but the Salford Corporation opposed both proposals, and as a result, Mr. Behr suggested to the Corporation that by a certain deviation he could avoid the open cutting, and take his line under a new street. The Corporation undertook at the time to give every facility to Mr. Behr for bringing in a Bill to authorise the deviation, but now they were opposing. He hardly knew now what the Salford Corporation were fighting for, for the only point which had arisen was with regard to a plot of land known as the Barracks site. When the Corporation showed Mr. Behr that site it was vacant land, but now the Corporation had allowed blocks of houses to be built upon it, and the promoters were prevented from executing their work unless they purchased these houses.

Mr. Freeman, K.C., for the Salford Corporation, said the whole object of the Corporation in opposing the Bill was to secure an undertaking that the promoters would not take these houses, and would not widen the street on the north side.

Mr. Moon said he could not give an undertaking not to take some portion of the Barracks site, for without doing so it would be impossible to get the requisite course of the line.

Later in the day, the parties having met, Mr. Freeman announced that the promoters had agreed to the following clause, and therefore opposition was withdrawn. The clause reads:—"Notwithstanding anything contained in this Act, the company shall not widen Tatton Street on the northern side thereof; and if for the purposes of this Act the company purchase or acquire any land of the said mayor, aldermen, and burgesses on the north side of the portion of Tatton Street which lies between Oxford Street and Gloucester Street and remove the buildings thereon, they shall erect on the site thereof new buildings of the same value, having a frontage to Tatton Street."

The Committee found the preamble of the Bill proved, and ordered it to be reported to the House for third reading.

Ashton and Dukinfield Corporation Bill.

The above Bill came before Lord Morley, the Chairman of Committees of the House of Lords, as an unnopposed measure on Tuesday last week. Under the Bill it was proposed to acquire the Alma Bridge and abolish tolls, so that the difficulty of constructing a satisfactory tramway service between the two towns may be done away with. It also gives power to the Corporation to lease any tramways or light railways which form junctions with the Corporation tramways, and further power is taken to sell and let for hire electrical appliances. The Bill was ordered to be reported to the House.

Southport and Lytham Tramroad.

The Bill promoted by the Southport and Lytham Tramroad Company came before Mr. Bowles's Select Committee of the House of Commons on Monday and Tuesday last week. The company is empowered to construct a tramway from Southport to the north along the seashore and then to bridge the estuary of the River Ribble with a conveyor bridge. Under the Bill a further extension of time for the completion of the undertaking is asked for, viz., three years for the tramway and five years for the conveyor bridge. The only petitioner against the Bill was Mr. Hesketh, the owner of an estate through which the tramway runs. The Committee declared the preamble of the Bill proved, and the clauses having been adjusted, the Bill was ordered to be reported to the House.

City of London (Streets) Bill.

On Monday and Tuesday last week Mr. W. S. Caine's Select Committee of the House of Commons had under consideration the City of London (Streets) Bill, which, amongst other things, sought to give the Corporation further powers over various authorities, companies, and persons having statutory and special rights to break up and open the streets of the City.

Mr. D. J. Ross, the City engineer, said the idea was to bring the Post Office, the Gas Light and Coke Company, the New River Company, the Hydraulic Power Company, the City of London Electric Light Company, and the Charing Cross and Strand Electricity Lighting Company, into line, so that proper notice of intention to open streets might be given.

After evidence had been called, and counsel had addressed the Committee, it was decided by the Committee to strike out the clauses in the Bill respecting the opening of streets.

London and Brighton Electric Railway.

The Earl of Morley presided on Thursday of last week over the Standing Orders Committee of the House of Lords for consideration of the report of the Examiner of petitions for private Bills on the above Bill, the allegation being that Standing Orders had not been complied with on a variety of matters.

Mr. Tetley, Parliamentary agent, who appeared for the promoters, explained the objects of the Bill, and said he believed that the new railway would be welcomed by the districts it was proposed to serve, and many of the local authorities had petitioned in favour of the Standing Orders being suspended. The London, Brighton and South Coast Railway, who were the principal opponents, had appeared before the Examiner, and had endeavoured to defeat the Bill on technicalities. The non-compliance reported by the Examiner did not damage or injuriously affect any person or property, without affording them the compensation provided by the general Acts. The memorialists had made a very large number of allegations of non-compliance, but they had only sustained a comparatively small number of them. The promoters submitted that the time had come when additional railway facilities between London and Brighton were essential, and it was proposed to utilise for that purpose the advances made in recent years in electrical science. The difficulty of preparing the plans and sections extending over nearly 50 miles of very difficult railway had been very great, and the errors which had been discovered by the opponents of the Bill were of a highly technical character, and at no point had any omissions or mistakes been made which would cause the construction of the railway, in accordance with the plans and sections, to be any source of injury in consequence of those errors. The Corporations of Brighton and Hove, and the District Councils of Hayward's Heath and Burgess Hill, the Borough of Reigate, the Keymer Urban District Company, the Cuckfield Rural District Company and the Clayton Parish Company, were all in favour of the Standing Orders being dispensed with. Having regard, therefore, to all the circumstances, the promoters asked their Lordships to adopt that course, so that the Bill might be allowed to proceed and be discussed on its merits.

Mr. Cripps, of Messrs. Dyson & Co., the Parliamentary agents for the London, Brighton and South Coast Railway, followed in opposition to the suspension of the Standing Orders, and said that the umulative effect of the inaccuracies in the proposed plans was very great.

The Chairman announced that the Committee had unanimously decided that this was not a case in which the Standing Orders could be dispensed with, and they, therefore, refused the request of the promoters.

Hastings Tramways.

The Hastings Tramways Bill was before the Standing Orders Committee of the House of Lords on Thursday of last week. Non-compliance had been reported in consequence of the withholding of the consent of the Corporation to the construction of the proposed new tramway along the sea front. Mr. Bell, the Parliamentary agent for the promoters, offered to insert in the Bill a clause to the effect that the circular system of tramways authorised in 1900 should be completed before the tramway along the sea front was proceeded with. The Committee decided to strike out that portion of the Bill relating to the new tramways, and only to allow that part to go forward relating to the extension of time asked for in connection with those lines authorised in 1900.

Birmingham and Midlands Tramway Bill.

Lord Morley presided on 20th inst. over the Standing Orders Committee of the House of Lords, when the Birmingham and Midlands Tramway Bill, which had failed to pass the Examiner, was considered. It was decided that the Standing Orders be dispensed with, and the Bill allowed to proceed on condition of the consent of the Oldbury Council being produced at the hearing on merits.

Newcastle-on-Tyne Corporation Tramways Bill.

On 20th inst. the Standing Orders Committee of the House of Lords considered the above Bill, which, when before the Examiner, was found not to have complied with the Standing Orders. It was stated that the Bill provides for the extension of tramways both within and without the City of Newcastle, and the consent of the local authority had not been obtained in the case of the tramway outside the City, and accordingly that portion of the Bill would be withdrawn. The clause dealing with the tramways outside the city were thereupon struck out, and the Committee allowed the Bill to proceed.

Gloucestershire Electric Power Bill.

The Gloucesteshire Electric Power Bill came before Mr. Jeffreys, the deputy chairman of Ways and Means as an unopposed measure on 20th inst., and was ordered to be reported for third reading. The Bill incorporates the Gloucestershire Electric Power Company with a capital of £250,000 to supply electricity in bulk to a large portion of the county. Two generating stations will be erected at Stroud and West Dean.

Mexborough and Swinton Tramways.

The Standing Orders Committee have reported that Standing Orders ought to be dispensed with in the case of the Mexborough and Swinton tramways and the Bill be allowed to proceed.

Tube Railways.

The following members of the House of Lords have been appointed to consider a number of the tube Bills, and the first sitting will be held on April 16th:—Lord Windsor (chairman), Viscount Knutsford, Marquis of Bath, Earl of Lauderdale, and Lord Zouche of Haryngworth. The Bills referred to them are as follows:—Charing Cross, Hammersmith and District Electric Railway (1 and 2), City and North-East Suburban Electric Railway (1 and 2), King's Road Railway, King's Road Railway (Putney Extension), North-East London Railway (1 and 2), Piccadilly and City Railway (1 and 2), West and South Junction Railway Bill, London United Railways Bill, Brompton and Piccadilly Circus Railway, and Central London Railway (new lines Bill).

Croydon and District Electric Tramways Bill.

The Standing Order Committee of the House of Lords have reported that in the case of the Croydon and District Electric Tramways Bill, the Standing Orders should be dispensed with, provided that Tramways 1, 23 and 24, be struck out of the Bill.

Rothesay Tramways.

The Chairman of Committees of the House of Lords, and the Deputy Chairman of the House of Commons, has reported with respect to the Rothesay Tramway (Extension) Provisional Order that the General Orders not complied with, ought to be dispensed with, and the order allowed to proceed, provided that the power to construct Tramways Nos. 1 and 2 be struck out of the order, and the consent of the County Council of Bute to so much of Tramway No 3 as affects the interest of the County Council acting as Royal authority be proved before the Examiner.

Garston and District Tramways and Electric Supply (Transfer) Bill.

The above Bill, which transfers to the Corporation of the City of Liverpool the undertaking of the Garston and District Tramways Company and the Garston and District Electric Supply Company, Limited, came before the Deputy Chairman of Ways and Means in the House of Commons on Thursday as an unopposed measure, and was ordered to be reported to the House for third reading. The Bill gives the Corporation of Liverpool power to borrow £136,000 for the purchase and acquisition of the undertakings, capital expenditure, and working capital, and the period assigned for repayment is 30 years.

South Shields and Sunderland Tramways.

On Thursday last week the Bill of the South Shields, Sunderland and District Tramways Company came before the Standing Orders Committee of the House of Lords.

Mr. Frere (of Messrs. Rees & Frere, Parliamentary agents), who appeared in support of the Bill, explained that it provided for the construction of tramways between South Shields and Sunderland. At present there were two tramways in South Shields, which carried traffic from the edge of the borough into the more central parts near the existing tramways, which belonged to a company which was associated with the promoters of the present Bill. The Examiner had reported that Standing Orders had not been complied with in respect of those two tramways, because certain notices had not been placarded in the streets of the borough. The position was that the promoters had instructed their local representative to do this, but he had through some oversight omitted to carry out their instructions. They had published advertisements in the *London Gazette* and in the local papers, and in December they had served notices on the frontagers in the streets through which the tramways would pass. The Corporation were promoting a Bill for the construction of tramways in the same streets, and they had issued a circular in which they stated that the promoters of the present Bill—the British Electric Traction Company—were seeking powers to construct a double line along the streets. He knew that technically that did not meet the requirements of the case, but he submitted that everybody in the street must have had full notice of what was the intention of the promoters.

Mr. Speechley, on behalf of the South Shields Corporation, asked their Lordships not to treat the Corporation notices as a compliance on the part of the promoters of the Bill. Such a claim, he said, was perfectly astonishing.

In the result the Committee allowed the Standing Orders to be dispensed with, and the Bill will accordingly proceed.

Exeter and District Tramways Bill.

The Examiners having reported a non-compliance with Standing Orders in the case of this Bill, the object of which is to incorporate and confer powers on the Exeter and District Tramways Company, it came before the Standing Orders Committee of the House of Lords last Thursday, in order that it might be determined whether the Standing Orders should be dispensed with, and the Bill be allowed to proceed or not.

On behalf of the promoters, the Parliamentary agent stated that the construction of the tramways in the City of Exeter had been abandoned, the Corporation not having given its consent to that portion of the Bill. It was announced that the Bill would be allowed to proceed, with those tramways struck out.

Electric Light Provisional Orders, No. 1.

On 21st inst. Electric Light Provisional Orders, No. 1, came before Mr. Campion, Examiner of Standing Orders. The Bill confirms provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888. The order relates to the following areas:—

Edmonton.—Order to the Urban District Council of Edmonton, in respect of the Urban District of Edmonton, in the County of Middlesex.

Enfield.—Provisional order granted to the North Metropolitan Electric Power Distribution Company, Limited, in respect of the Urban District of Enfield, in the County of Middlesex. The order provides that the local authority may, if they think fit, within six months after the expiration of the period of 16, 21, and 28 years from the commencement of the order, give two years' notice in writing to the undertakers requiring them to sell, and upon the expiration of such notice the undertakers shall sell upon the following terms:—The local authority shall pay to the undertakers a sum equal to the value of the undertaking as a going concern, regard being had to the profits earned by the company in the preceding five years, and with due allowance for depreciation, but without any addition in respect to compulsory purchase or prospective increase of profits. Any differences which may arise shall be settled by arbitration. After the expiration of 35 years, the local authority shall be entitled to purchase the undertaking upon the terms, and in the manner specified in Clause 2 of the Electric Lighting Act of 1888.

Tottenham.—Order granted to the Tottenham Urban District Council in respect to the urban district and parish of Tottenham in the County of Middlesex.

Wood Green.—Provisional order to the Wood Green Urban District Council in respect to the urban district of Wood Green in the County of Middlesex.

Standing Orders were found to have been complied with.

Petitions.

Amongst the petitions which have been deposited in the Private Bill Office are petitions from the Lambeth Waterworks Company, the Wandsworth Corporation, and the Surrey County Council against the Croydon and District Electric Tramways; the Metropolitan District Railway Company, the Deptford Borough Council, and the Wandsworth Corporation against the L.C.C. (Tramways and Improvements Bill).

Torquay and Paignton Tramways.—On this Bill coming before the Examiner for proof of compliance with Standing Orders, there was no attendance on behalf of the promoters, and accordingly the Bill drops this session. It was proposed under the Bill to authorise the incorporation of a company with a capital of £160,000, to lay down and equip electric tramways in the Borough of Torquay and the Urban District of Paignton.

The Sheffield Corporation has deposited a petition in the House of Lords against the Derbyshire and Nottinghamshire Electric Power Bill.

Whitechapel and Bow Railway.—The Standing Orders Committee has reported that Standing Orders may be dispensed with in the case of the application by this company for an additional provision in their Bill of this session. The particulars have already been given in the Electrical Review.

South Wales Electrical Power Bill.—On Tuesday last week the South Wales Electrical Power Company came before Mr. Campion, the Examiner, with an application for additional provisions in their Bill of this session. The application was to insert the following new clause after Clause 9:—"The company may, by agreement (but not otherwise), acquire from any local authority or other undertakers to whom a provisional order under the Electric Lighting Acts, 1882 and 1888, shall have been granted relating to a district or place within the company's area of supply, the undertaking authorised by such provisional order, and any such undertakers may, with the approval of the Board of Trade, transfer their undertaking to the company on such terms and conditions as may be agreed upon, and in the event of the company so acquiring such undertaking, they shall be entitled in respect of the supply of electric energy to and within the district or place defined by such provisional order, to charge rates or prices not exceeding those limited by such provisional order." It was found that the necessary Standing Orders had not been complied with, and accordingly the Bill will go to the Standing Orders Committee to deal with.

Croydon and District Electric Tramways.—The Standing Orders Committee report that in the case of the Croydon and District Electric Tramways Bill Standing Orders should be dispensed with, and the parties be permitted to proceed with their Bill provided that the powers to construct Tramways Nos. 1, 23 and 24 be struck out. Tramway 1 was to have commenced at Merton Road, Tooting Graveney, by a junction with the L.C.C. tramways, and terminate in the Mitcham Road by a junction with the light railway proposed to be authorised by the Mitcham Light Railway Order, 1901. Tramway 23 would have commenced at Red House Road, Penge, and terminated at the Lewisham boundary. Tramway 24 joined on to Tramway 23 and terminated in Sydenham Road.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Mar. 19th, 1901.		Week ending Mar. 18th, 1902.	
Adelaide	Value £46	Adelaide. Teleph. cable	Value £274
,, Teleg. cable	27,000	Alexandria	21
,, Teleg. mat.	60	Amsterdam	130
,, Teleg. wire	390	Barcelona	17
Amsterdam	76	Beira. Teleg. mat.	2,229
Auckland	100	Bombay	458
Bombay	82	Bremen	125
Brisbane. Teleg. cable	274	Buenos Ayres. Teleg. mat.	80
Buenos Ayres	84	Calcutta	150
Calcutta	1,685	Cape Town	460
,, Teleg. cable	725	Christchurch	21
,, Teleph. cable	195	Colombo	90
,, Teleg. wire	116	Constantinople	23
Cape Town	758	Copenhagen. Teleg. wire	107
Colombo	14	Durban	241
Cologne. Teleg. cable	1,102	East London	31
Copenhagen. Teleg wire	18	Fremantle	56
Demerara	316	,, Teleph. mat.	278
,, Teleg. mat	82	Gibraltar	250
Durban	154	Halifax	85
,, Teleg. wire	363	Hong Kong	192
Flushing	25	Melbourne	461
Gibraltar. Submarine cable	1,750	Nagasaki	290
Kobe. Teleg. cable	8,650	Otago	120
Malta. Teleg. cable	1,750	Paris	30
Melbourne	1,944	Perth	890
,, Teleg. mat.	44	Port Elizabeth	21
Nagasaki	747	Shanghai	48
Ostend	25	,, Teleg. wire	119
Penang	18	Sydney	723
Perth	180	,, Teleg. wire	1,390
Port Chalmers	126	Wellington	425
Port Said	15		
Rockhampton	54		
St. Petersburg. Teleg. mat.	34		
San Sebastian	85		
Shanghai	311		
Singapore	906		
,, Teleg. mat.	346		
Sydney	409		
Wellington	285		
Yokohama	466		
Total	£51,209	Total	£9,275

Foreign Goods Transhipped.

Gothenburg. Teleph.apprts. Value £15

American Exports.—Returns just issued show that during last year the value of the electrical machinery exported from the United States reached a total of £1,124,688, as compared with £1,057,245 in 1900.

Association of Engineers-in-Charge.—The seventh annual dinner of this Association took place on Saturday last, 22nd, under the presidency of Mr. Maurice Fitzmaurice, M.I.C.E., the recently appointed chief engineer to the London County Council. There was a very large attendance, and a pleasant evening was spent. The speakers, in addition to the chairman, were Messrs. T. W. Hatch, A.M.I.C.E., and W. C. Clifford-Smith, M.I.C.E. (vice-presidents of the Association), A. Davey (hon. sec.), J. Cox, (Shoreditch Borough Council), and T. Aldworth (chairman of the Association). The last-named gentleman, speaking of international competition, related that he once asked an American how his country was enabled to compete so successfully with our own; and he said that it was by paying twice as much in wages, and thereby getting three times the output. A German, when asked the same question as to German competition, explained that it was owing to the fact that in his country the workman was paid only half what the British operative received!

Auction Sales.—Particulars appear in our business pages to-day of two auction sales which are to be conducted by Messrs. P. Huddleston & Co. on April 4th and 8th. At Plumstead electrical and other plant is to be disposed of, and at Limehouse leasehold premises with machinery, stock-in-trade, and plant at Burdett Works (motor car building) will be offered.

Messrs. Morris & Place on April 16th will conduct a sale at Nottingham of certain engineering works. Full details of the plant and equipment are given in our advertisements.

Bankruptcy Proceedings.—Under the failure of John H. Redgrave, electrical engineer, Regent House, Regent Street, W., and New Barnet, the adjourned meeting of creditors was held on Monday at the London Bankruptcy Court before Mr. C. A. Pope, assistant receiver. Full particulars of the case have already appeared in these columns, and it will be remembered that the debtor is wanted by the police in connection with a charge of obtaining money by fraud, but his arrest had not yet been effected. A resolution was passed for Mr. Alfred Bevis, 11A, Union Court, Old Broad Street, E.C., to act as trustee, and administer the estate in bankruptcy, assisted by the following committee of inspection:—Mr. Manton (representing Mr. Cridland, the petitioning creditor), Mr. Downing and Mr. G. B. Barnes. The trustee's bond was recommended at £1,000, the assets being stated to consist of bank balances, household furniture and wine. The proofs tendered by creditors amounted to £5,000.

Notice of a first and final dividend of 5½d. in the £ is given in the case of W. V. Scott, electrical engineer, Shaftesbury Road, East Hammersmith.

Liquidation.—A meeting of the Roller Bearings Company will be held on Thursday, April 24th, at 73, Basinghall Street, E.C., to hear an account of the liquidation proceedings from Mr. F. L. Fisher, the liquidator.

The Case of Charles Bright.—Charles Bright, of Buenos Ayres, again appeared on 20th inst. on the charge of having, with intent to defraud his creditors, concealed a large number of shares in Charles Bright & Co., Limited, and Bright's Light and Power Company, Limited. The defendant Bright read a lengthy statement, in which he said the case would be at an end if he proved that the shares in question did not belong to him. In the years 1890 and 1891, having been very ill for some time, his friends advanced him money with which to start business. He went to the Argentine Republic, where he constructed the first electrical tramway. In the first year he cleared £50,000, and in the second made a fortune of £100,000. He proceeded to repay what had been lent him, for which he was thrust into prison on arriving in England in 1902. The prosecution accused him of being a company promoter, whereas, as a matter of fact, he was a victim of promoters, who had brought the present charges against him to prevent him from prosecuting them. He had sworn that he was worth between £300,000 and £400,000 in Buenos Ayres, but that did not prevent an affidavit from being filed stating that in his public examination he had declared that he had no assets whatever. As a matter of fact, he did not know even now what shares he was charged with stealing. He characterised this as a malicious prosecution, and said there was not a jot of evidence against him of any intent to defraud. His books spoke for themselves, and proved the very opposite to the theories which the prosecution had attempted to establish. He further alleged (says the *Times* report) that his bankruptcy had been brought about by false statements. Mr. Alderman Smallman again adjourned the case.

Catalogues.—The Electric Welding Company, Limited, of 28, Basinghall Street, E.C., have brought out a new catalogue of electric welding machines and apparatus (Thomson process) for welding, tempering, annealing, brazing, forging and shaping metals. The advantages of the process are detailed, and some notes are given of industries in which it may be successfully applied. A number of interesting letters from users are printed, showing results which have been obtained with the Thomson apparatus.

The Liverpool Electric Cable Company have published a new price list of their electric wires and cables. The tabulated matter is very clearly arranged, the general details being printed in a bright blue colour, and the prices neatly brought out in red. The catalogue will be of service to users and purchasers of wires, cables, jointing materials, and so on. The patent Clincher cable clip is described.

From the Klein Engineering Company, Limited, of 94, Market Street, Manchester, we have received a number of illustrated lists and catalogues of their specialities, including vacuum pumps, air compressors, condensing plants, and cooling towers. There is a large number of excellent illustrations, and a list of places and firms for which Klein's plant has been supplied. We learn that this company has received an order from the Manchester Corporation for a battery of four water cooling towers, to deal with the water for condensing 120,000 lbs. of steam per hour, the same being the largest of three orders into which the Corporation decided to divide the lot of 10 towers required for their Stuart Street electricity station. The same firm have during the present year received orders for condensing and water cooling plants to deal with about 600,000 lbs. per hour, in which are included the following:—Manchester Corporation electricity station, 120,000 lbs. per hour; Mexican Gas and Electric Supply Company, 110,000 lbs. per hour; Bolckow, Vaughan & Co. (steel works), 90,000 lbs. per hour; South Lancashire Electric Tramways Company, 45,000 lbs. per hour; Bournemouth Corporation electricity station, 33,000 lbs. per hour; Bolton Textile Mill Company, Limited (cotton mill), 30,000 lbs. per hour; Fletcher, Burrows & Co. (colliery), 20,000 lbs. per hour. We understand that within about three years the company has turned out condensing and cooling plants for dealing with 1,500,000 lbs. of steam per hour, and it hardly needs to be said that engineers generally in this country are appreciating more than ever before the importance of condensing.

Messrs. Mavor & Coulson, Limited, of Glasgow, have placed before us a beautifully got-up catalogue, with art paper, and illustrations describing very fully the electric bar coal-cutting machines (Hurd's patent). A comparison of bar with disc machines is included.

The Lahmeyer Electrical Company, Limited, has issued a new list, No. 14, of electrically-driven portable drills. Several illustrations show drills in operation, and sectional drawings detail their construction.

Messrs. O. Berend & Co., Limited, have sent us copies of their new trade price lists, No. 26, Sections I. and II., which refer fully to Hartmann & Braun's electro-magnetic instruments (switchboard pattern), also the H. and M. moving-coil instruments. Both lists are well illustrated.

Charges of Stealing.—We are informed that on 21st inst. at the Westminster Police Court, a wireman, named Stuart, and a labourer, named Vince, were charged with having stolen 1½ cwt. of old lead-covered wires from St. Matthew's Church, Westminster, the property of Messrs. Eastlakes, Limited, of Cowley Street, Westminster. The prisoners admitted taking the material, and were fined £5 or in default one month's imprisonment.

The Flame Arc Lamp.—The Union Electric Company, Limited, of 151, Queen Victoria Street, E.C., have sent us a pamphlet, No. 1,454, briefly descriptive of this lamp, which they are now, after extensive practical trials, putting on the market. The following figures of tests have been supplied to us to demonstrate the increased candle-power of the direct-current lamp:—

Flame Lamp.		Open Arc Lamp.	
Amperes.	Mean C.P.	Amperes.	Mean C.P.
7	1,320	7	610
9	1,700	9	895
12	2,125	14	1,365

The alternating-current lamp tests were as follow:—

Flame Lamp.		Open Arc Lamp.	
Amperes.	Mean C.P.	Amperes.	Mean C.P.
12	1,064	12	410
15	1,554	15	550
18	1,883	18	680

The open arc was taken for comparison owing to its higher efficiency than the enclosed. The voltages of the lamps are approximately the same in each case, in fact, we understand that the watt-consumption was identical. The candle-power is the mean hemispherical in Hefner candles. The light is difficult to describe—it is not the steel-white of an open arc, nor the yellow colour of some metallic arcs, but a light somewhere between, that gives a cheerful appearance to its surroundings. The lamp is of a special internal and external construction; it is claimed that, owing to the flame arc, the entire globe appears radiant. We recently inspected the lamp, and we shall deal with it more fully later.

Boiler Test.—We have received some interesting particulars of a test recently made at the Belfast Corporation Electricity Works, on a Babcock & Wilcox water-tube boiler fitted with the "Bennis" stoker and self-cleaning compressed air furnace. The results were briefly as follows:—

Duration of trial		5½ hours.
Calorific value of coal by calorimeter		14,049 B.Th.U. per lb.
Heating surface of boiler		4,228 sq. ft.
Grate surface		50 sq. ft.
Ratio of heating to grate surface		84·56 : 1.
Steam pressure by gauge (average)		161·4 lbs. per sq. in.
Average temperature of superheated steam leaving boiler		525° F.
Number of degrees F. of superheat		154
Feed-water temperature (average)		66·5° F.
Total fuel burnt		9,243 lbs.
Fuel burnt per sq. ft. of grate per hour		35·2 lbs.
Percentage of carbonic acid in flue gases leaving boiler (average)		14·5 per cent.
	Actual conditions	From and at 212° F.
Total water evaporated	92,000 lbs.	110,565·6 lbs.
Water evaporated per hour	17,523·8 lbs.	21,060·1 lbs.
Water evaporated per sq. ft. of boiler heating surface per hour	4·14 lbs.	4·98 lbs.
Water evaporated per lb. of coal	9·95 lbs.	11·96 lbs.
Thermal efficiency of boilers with Bennis stoker and furnace		82·29 per cent.
Thermal " " " including superheat		87·46 "

The results speak for themselves. The remarkably high efficiency, combined with the very rapid evaporation, constitutes, we believe, an entirely new record, highly creditable to both Messrs. Babcock and Wilcox, and Messrs. Bennis & Co., Limited.

Electric Pumping Plant at Eldon Colliery.—Messrs. Ernest Scott & Mountain, Limited, Newcastle-on-Tyne, have recently completed an electric pumping plant for the South Durham Coal Company for their Eldon Colliery, this plant being one of the largest of its type in the kingdom. The plant consists of a compound coupled horizontal engine, with high pressure cylinder 18 in., low pressure cylinder 30 in., by 40 in. stroke, running at 80 revolutions per minute, and capable of giving 440 I.H.P. with a steam pressure of 100 lbs. per sq. in. This engine is used for driving the pumps at present installed, and has sufficient capacity for driving a third set of pumps which it is proposed to place at the 600 ft. level, and also the dynamos for working the coal-cutting machines. The engine drives by cotton ropes on to a "Scott & Mountain" over-compounded multipolar generator of their latest type, the machine being constructed to give an output of 220 KW. at an E.M.F. of 500 volts on open circuit, or 550 volts at full load when running at a speed of 400 revolutions per minute. The dynamo is fitted with an extended bedplate with outer bearing, the pulley shaft being independent from the armature shaft and coupled by turned steel bolts. The current from the dynamo is taken to a main switchboard, on which the usual instruments are fitted, *i.e.*, amperemeter and voltmeter, also an overload circuit breaker and shunt regulator. The generating machinery is placed at the Harry pit, the current being taken to the John Henry pit, a distance of half a mile, by overhead conductors consisting of four cables, each composed of 19 wires No. 11 S.W.G. run on poles with insulators. At this point it is taken down the shaft through heavily insulated and armoured cables to the pump room, the length of the shaft cables being 150 yards each. In the pump room there are two sets of the firm's three-throw ram pumps with rams 11 in. diameter by 18 in. stroke, each pump delivering 500 gallons per minute, or collectively 1,000 gallons, against a head of about 400 ft. when running at a speed of from 27 to 28 revolutions per minute. The pumps are of the firm's latest design, with gun-metal rams, independent pump barrels, valve boxes and connecting pipes. The two motors are each of Scott and Mountain's four-pole type, with extended bedplates capable of developing 120 effective H.P. each at a speed of about 450 revolutions per minute. These motors drive by cotton ropes on to the pumps, which system of driving takes all jar off the motor armature. The plant has now been constantly at work for over two months, and we learn that in order to prove the efficiency an exhaustive set of tests have been made with the following satisfactory results:—One boiler, 30 ft. long by 7 ft. diameter, of the Lancashire type, was easily capable of supplying steam to the engines when driving the two sets of pumps to their full capacity, and the coal consumption was 906 lbs. per hour, the coal being of ordinary quality. The pumps delivered 64·8 gallons of water against a head of about 400 ft. per lb. of coal used in the boilers. The efficiency between the actual electrical output at the dynamo terminals and the horse-power in the water pumped, the pumps being a distance of 1,000 yards from the generator, was 72·7 per cent. The efficiency between the electrical horse-power at the motor terminals and the actual horse-power in the water pumped was 77·4 per cent. The efficiency of the motors was 91 per cent. The efficiency of the pumps, *i.e.*, the difference between the actual horse-power applied at the motor shaft and the horse-power in the water delivered, was 85 per cent. The high efficiency of the pumps is due no doubt to their low speed, and also to the use of machine-cut gearing throughout and the very large valves used, but although this efficiency is high, no doubt a still higher efficiency would be obtained against greater heads.

Hiko.—This is an American commutator composition, sold by the Electrical Appliances Syndicate, Limited, Liverpool. We have had it tested for some time on commutators, and learn that it is very useful for cleaning them—the principal property claimed for it by the makers. It is a non-conductor, and is said to be equally effective with copper and carbon brushes.

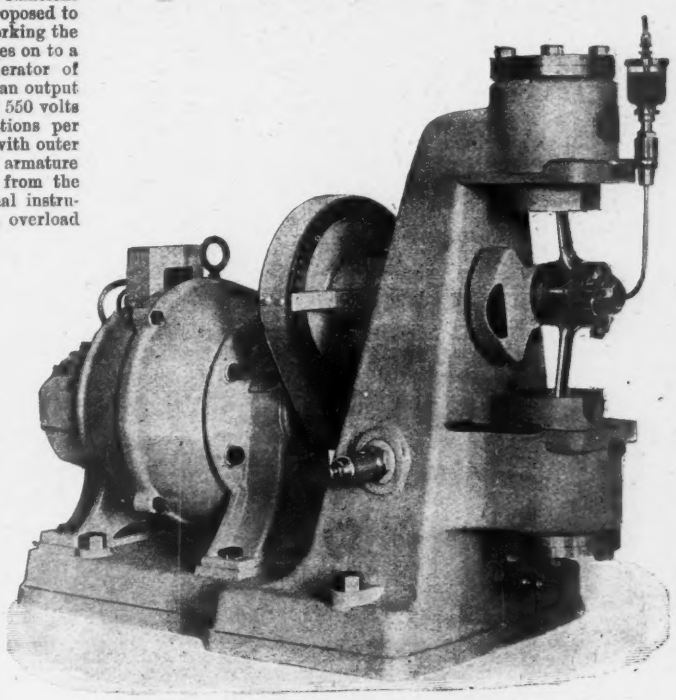
Trade Announcements.—We are informed that the Iroquois Machine Company has just been incorporated as a New York company to manufacture new and improved wire-drawing machinery, which, it is claimed, will materially reduce the cost of producing wire. They will also manufacture a full line of automatic and plain drop hammers, swaging machines, rolling mills, roller bearings, and grinding machines. They have purchased the plant and business of the Universal Machine Company, located at Providence.

Messrs. De Puydt & Poncin, of Marion Street, Birkenhead, ask us to state that their Birkenhead office and a portion of the works having been destroyed by fire, they will be glad if firms with whom they have had business relations will send duplicate copies of their catalogues, &c.

Messrs. Easton & Co., Limited, announce that, having now completed the reorganisation of their electric and hydraulic lift department, they have placed the sales branch in charge of Mr. P. Ibbotson Unwin, who has had great experience with this class of work, and they are now in a position to supply not only the large-sized lifts which have always been a feature with them, but also for small lifts suitable for hotels, offices, private houses, &c.

Messrs. Ernest Scott & Mountain, Limited, of Newcastle-upon-Tyne, notify that their works will be closed from Thursday night, 28th inst., until Wednesday morning, April 2nd, for Easter holidays.

Electrically-Driven Compressors.—Messrs. Reavell and Co., Limited, of Ipswich, have issued circulars describing their small compressors. The electrically-driven type is being supplied to electric lighting and power stations. It is of the patented duplex type, and has a capacity of 18 cub. ft. of free air per minute. It is driven by a motor of the enclosed type, of 1½ to 2 H.P., depending on the delivery pressure. The frame of the compressor is designed so as to form an air reservoir, and is fitted with relief valve, drain cock, and outlet connection screwed 1 in. gas. The base of the compressor is extended to carry the motor, which runs at about 1,200 revolutions per minute, and drives the compressor at 400 revolutions per minute through gear-wheels, the pinion being of raw hide, and the spur-wheel of cast-iron, machined from a solid blank. The gears are protected by a neat planished steel case. The motors are supplied to suit any desired voltage. The machine is designed for delivery pressures up to 30 lbs. per sq. in., and is usually worked at 15 to 20 lbs. pressure.



ELECTRICALLY-DRIVEN COMPRESSOR.

The Keighley Lamp Pillar and Switch.—The Keighley Electrical Engineering Company, Limited, of Vulcan Works, Keighley, are manufacturing a lamp pillar switch on a new principle for incandescent street lighting. It is a water-tight quick-break double-pole switch combined with a double-pole fuse, and it is said to be impossible for any arcing to take place inside the

FIG. 1.

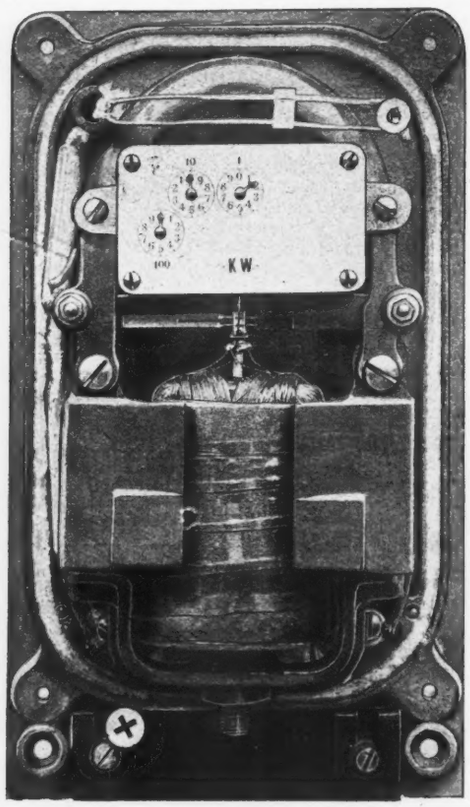
FIG. 2.

switch. Perfect insulation of the switch parts and case is claimed. For renewing the fuse, the switchblock, which carries the fuses, is withdrawn from the case entirely, thus assuring absolute safety to the attendant and impossibility of short circuit between terminals inside the switch. We learn that the switches have been tested up to 10 times their normal capacity on short circuit without the

Fig. 3.

slightest injury. Fig. 1 gives a general idea of the appearance of the switch; fig. 2 shows it fixed in position; and fig. 3 illustrates the parts.

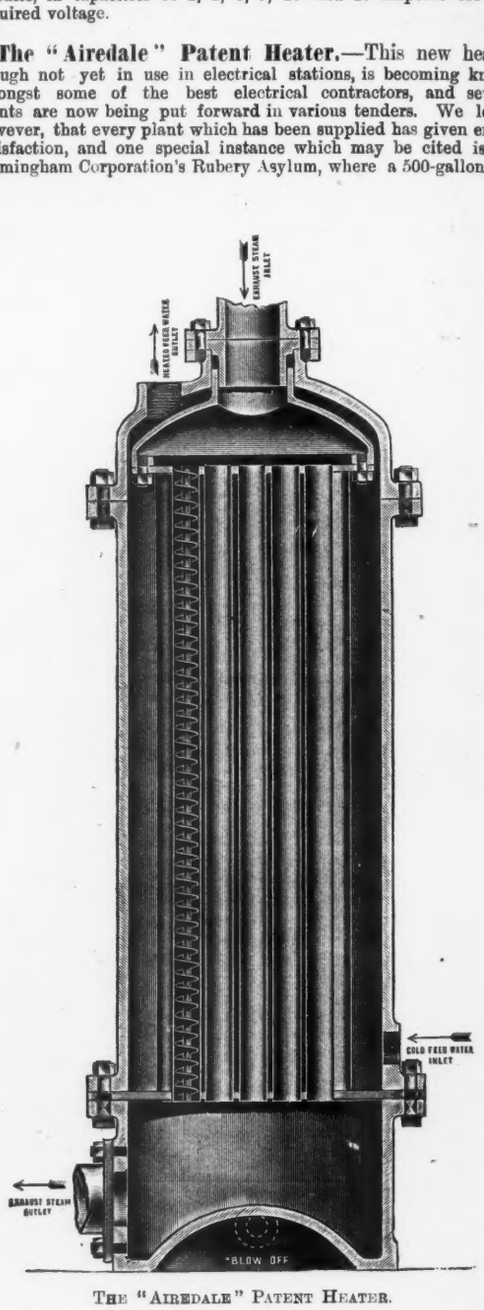
The O.K. Meter.—We illustrate herewith the type O.K. ampere-hour meter of the B.T.H. Co. for continuous current circuits. The makers have introduced this meter to meet the demand for an inexpensive ampere-hour meter of small capacity and great accuracy. It is constructed for use on two and three-wire continuous-current circuits only, and for capacities of



The O.K. Meter.

15 amperes and under. The registering mechanism of the O.K. meter is so adjusted as to be read directly in KW.-hours on the usual dial, the volts on the circuit averaging the number stamped on the nameplate. The armature or movable part is made as light as possible, so as to reduce to a minimum the wear on the bearing jewel and pivot. The meter is said to be practically independent of temperature variation. The meter is entirely enclosed in a dust-proof cover, and all parts are protected from mechanical injury. The cover is arranged in such a manner as to permit of connections being made and sealed without exposing the measuring mechanism. All parts are properly insulated, so that the danger from a ground is eliminated. There is approximately one-half a volt drop due to the instrument resistance with full load, and so the loss of energy from this source is negligible. The motor starts with 1 per cent. of the full load current or less, thus ensuring a high degree of accuracy on the smallest loads (one 5-C.P. lamp) which the instrument is expected to record. The O.K. ampere-hour meters are manufactured for use on constant potential continuous current two and three-wire circuits, in capacities of 1, 2, 3, 5, 10 and 15 amperes for any required voltage.

The "Airedale" Patent Heater.—This new heater, though not yet in use in electrical stations, is becoming known amongst some of the best electrical contractors, and several plants are now being put forward in various tenders. We learn, however, that every plant which has been supplied has given entire satisfaction, and one special instance which may be cited is the Birmingham Corporation's Rubery Asylum, where a 500-gallon size



The "Airedale" Patent Heater.

was supplied some nine months since. The "Airedale" heater is claimed to be a very effective type, and it is made by Mr. John Barrett, of Eastburn Foundry, Crosshills, Keighley, the apparatus being constructed in accordance with the patent of Mr. G. Green. The construction of the apparatus is clearly shown in the accompanying illustration. The supply of exhaust steam enters the vessel at the top into a dome-shaped chamber, from whence it passes downwards through a series of straight solid drawn brass tubes into a chamber at the bottom before escaping into the atmosphere or passing forward to the condenser. This dome-shaped chamber and the tubes are contained in an outer vessel, through which the feed water circulates, entering at the bottom and leaving at the top, so as to move in a direction opposite to the flow of the steam. In order to ensure perfect freedom for the

expansion and contraction of the tubes, and thus avoid the risk of leakage which occurs when the tubes are held rigidly between two tube plates, the whole of the tubes and dome-shaped chamber at the top, to which they are attached, are perfectly free to move at their upper end. This is effected by means of a short neck at the top of the dome chamber, which slides freely in a gland (as shown in the illustration), this gland being packed with an elastic packing which, while allowing freedom for the variation of the length of the tubes owing to expansion and contraction, forms a steam and water-tight joint. The special feature of the heater, however, consists of a patent spiral deflector which is inserted within each tube, and which is indicated in the illustration by the one shown in section. By the aid of this deflector, the core of steam passing through the tube is compelled to acquire a rotary motion at great velocity, which, owing to the centrifugal force, throws the steam into close contact with the surface of the tube, sweeping from the surface the drops of condensed steam which naturally collect on the interior of the tubes as a result of the heat abstracted by the feed. This permits of a rapid transfer of heat from the steam to the water, and it has been found that a tube fitted by a deflector in this way shows an efficiency twice as great as a plain tube without the deflector. In other words, a tube 2 ft. long fitted with the deflector will transmit the same amount of heat in a given time as a similar tube 4 ft. long without the deflector. The following particulars have been furnished of a test which were made some time since, and which will serve to illustrate the difference in question. The test was made upon an actual heater designed with sufficient heating surface (as is allowed in ordinary practice) to heat 200 gallons per hour to about 200° F. when working with ordinary straight tubes without deflectors. The heater shell in both cases was filled with water at 70° F., then steam was supplied through a ½-in. pipe at 212° F. at equal velocity in each test, and the temperature of the water in each case was as follows:—

Without deflectors. Temp. at start 70° F.	With deflectors. Temp. at start 70° F.
Temp. in 18½ minutes 180° F.	Temp. in 2½ minutes 180° F.
Temp. in 21½ minutes 190° F.	Temp. in 3 minutes 190° F.
Temp. in 23½ minutes 200° F.	Temp. in 5 minutes 200° F.

The temperature in each case was taken at the surface of the water in the shell, and all the steam was condensed in the tubes when the deflectors were used, whereas when deflectors were not fitted a great portion of the steam passed through the tubes without in any way heating the water. The above experiment is claimed to show that such an apparatus is more compact, and relatively more efficient, than is possible with a heater with plain tube surface. In fact, the test apparatus designed for 200 gallons with plain tubes was put down some 15 months since at the works of Messrs. John White & Son, Limited, curriers, of Bingley, Yorks., under guarantee that, with the deflectors fitted, it would heat 400 gallons of water per hour, and this, we understand, it continues to do to this day, heating the water to a temperature of 203° F. after passing through about 30 ft. of 1½-in. pipe uncovered, whilst indicator diagrams show that no appreciable back pressure is put upon the engine.

ELECTRIC LIGHT AND POWER NOTES.

Arbroath.—A large private electric power plant has been put down by Messrs. Andrew Lowson, Limited, to drive their flax-spinning mills, the generating plant, supplied by the British Schuckert Electric Company, having a capacity of 1,000 H.P.

The power station consists of three Lancashire boilers by Messrs. J. Carmichael & Co., Limited, Dundee, supplying steam at 160 lbs. pressure. The engine is by Messrs. Willans & Robinson, Limited, Rugby, and is of the three-crank compound type, running at 270 revolutions per minute. The work has been done under the supervision of Mr. R. D. Munro, Glasgow.

Aston.—The D.C. has considered the tenders for the erection of a generating station and cables, and has accepted those of various electrical firms, representing in the aggregate the sum of £62,970.

Blackburn.—The Corporation was last week fined 40s. and costs on a prosecution of the borough medical officer, for allowing the chimney of its electricity works to emit black smoke.

Bristol.—A report is before the T.C. recommending the extension of the public electric lighting by means of 366 arc lamps, costing £14 10s. per lamp per annum. If these are installed, however, the Electrical Committee undertakes to reduce the price charged for 310 existing arc lamps by £2 each; deducting also the cost of gas for 555 gas lamps replaced, the net increase in expenditure amounts to £2,763 per annum.

Brighton.—On the advice of Mr. Wright, the consulting electrical engineer, who stated that the tramway plant was fully loaded and at times considerably overloaded, the Corporation has decided to double the present capacity by installing a 325-KW battery, which will be of permanent use when the Southwick supply is available. Application will be made to the L.G.B. for sanction to borrow £5,500 for the purpose.

The resident electrical engineer (Mr. Christie) has asked the Council's approval to the following annual rentals for the hiring out of motors. The figures are based on approximately 15 per cent. of the total cost of the motors, and larger motors would be quoted for on the same basis:—

H.P.	Annual rental for standard motors payable quarterly in advance.
½	£1 15 0
1	2 5 0
5	6 10 0
10	10 0 0
15	12 0 0

Broughty Ferry.—The T.C. has decided to proceed with the erection of an electricity works, to the plans of Mr. G. Balfour of Dundee.

Chatham.—The new electric cars that are just about to run at Chatham and New Brompton, under the direction of the Chatham and District Electric Tramways Company, have arrived at the car-shed, near the generating station at Luton. They were manufactured by Messrs. Milnes, and are double-deckers to carry 24 passengers inside and 26 out. They have the reversed staircase. The generating station is not yet quite complete, but it will be in a few weeks. An automatic "cut-off" system, by which the current can be instantly interrupted in the case of a wire snapping, has been adopted.

Finchley.—The U.D.C. has approved of the estimates prepared by the electrical engineer for electricity works as follows:—Buildings, £8,000; machinery, £10,600; mains, £14,150; sundries, £2,250; total, £35,000. Application is to be made to the L.G.B. for sanction to a loan.

Glasgow.—Reporting to the Electricity Committee as to the closing of Waterloo Street station and the purchase of additional plant for Pollokshaws Road station, Mr. Chamen stated that the Waterloo Street plant, which is represented by the present book value of £29,327, could be sold for £13,850. The capital expenditure required to replace this would be £17,937, making a net increase to the present capital expenditure of £4,087. The Committee recommended that the offer of Messrs. Willans & Robinson for two new engines of 2,400 H.P. each and dynamos for £24,074 be accepted, the firm to purchase certain plant at Waterloo Street; that the Waterloo Street premises be discontinued as a generating station, and that tenders for the remaining plant for next winter's requirements be advertised for.

Mr. Chamen points out that the cost of wages in running Waterloo Street works, apart from repairs, amounts to about £2,000 per annum. If the Waterloo Street plant were replaced by new plant in Pollokshaws Road station, the saving would amount to about £1,735 per annum. The Sub-Committee on Works recommended that an offer by Nobel's Explosives Company, Limited, to purchase two steam dynamos with one spare armature and stop and exhaust valves for the sum of £675 be accepted. The original cost of this plant was £1,615, but it has been written down to £906. The report was adopted by the Council, and Messrs. Willans & Robinson's tender for the two new engines is to be accepted, on condition that the 11 engines and certain dynamos at present in Waterloo Street Station be purchased by them for £8,036.

During the debate Bailie Maclay stated that his sub-committee had been conferring with the Tramways Committee, as he understood they had a considerable amount of surplus power, and he was of opinion that the two departments could help each other considerably. Papers and particulars regarding this matter, as well as the abandonment of Waterloo Street Station, would be laid on the table, and opportunity given for discussion before any steps were taken.

New feeders are to be laid in Abbotsford Place and South Portland Street.

Govan.—The T.C. has adopted the following scale of charges for the year 1901—1902:—Lighting, ordinary consumers, 6d. per unit for the first hour's use of the maximum demand, and 1d. per unit afterwards; domestic consumers, theatres, halls, &c., 3½d. per unit; churches, 3d. per unit; stair lighting, 5-E.P., £1 5s.; 8-C.P., £1 7s. 6d.; 16-C.P., £1 17s. 6d. per annum. Power, 1½d. per unit.

Hythe.—The Folkestone Electric Supply Company has taken over the Hythe Prov. Order, and will light the streets at 3d. per unit. For power purposes the price is 4d. per unit, and for private lighting 7d.

Kingston.—At a meeting of ratepayers, the extension of arc lighting in the main streets has been condemned, and a resolution was carried calling upon the T.C. to consider the whole question of public and private electricity supply.

Kinning Park.—The electric lighting of the streets of this borough was inaugurated on 19th inst. The supply is obtained from the Glasgow Corporation electricity station at Pollokshaws Road.

London.—L.C.C.—The Council has granted an application from the Islington B.C. for sanction to the borrowing of £10,438, the balance of actual expenditure on the building of the Eden Grove electric lighting station over the amounts formerly sanctioned.

Lowestoft.—A L.G.B. inquiry concerning the application of the Town Council to borrow £7,143 for works connected with the electric lighting undertaking was held last week before Mr. J. C. Pottinger, M.Inst.C.E., one of the Board's inspectors. It was stated that £5,700 represented a new 500-kw. set, alterations of switchboard, &c., and £1,400 was for a condensing plant. Mr. G. A. Bruce, resident electrical engineer, stated that they had at present the equivalent of 10,400 8-c.p. lamps on their mains, and applications for nearly 1,700 lamps.

Medomsley.—The Parish Council has resolved to light the village with electricity instead of gas, providing satisfactory terms can be arranged with the Consett Iron Company.

Ross.—It has been definitely decided to start the Ross Electric Light and Power Company, Limited; and the tender of the India-rubber, Gutta-percha, and Telegraph Works Company, Limited, of Silvertown, for plant and machinery, has been accepted.

Southport.—The Corporation has decided to make the same charge for special illuminations for the Coronation as at the time of the Diamond Jubilee. No matter how long the decorations are kept lighted, the charge will be ½d. per lamp per night up to 12 o'clock. The Pier authorities have agreed to take 7,500 units per annum at 4d. per unit.

Slough.—An inquiry was held at the B. of T. last week in reference to an application by the Slough U.D.C. for a prov. order to supply electricity in Slough and Datchet.

Sutton.—The Sutton Lighting and Power Distribution Company, which acquired the U.D.C.'s prov. order, has commenced supplying customers, who are increasing in number daily. The installation includes two 300-h.p. Babcock & Wilcox boilers and water-softening plant; the engine is of the Brush Universal type, and the generator, a Brush inductor alternator, is of 150-kw. output. A similar engine and generator is kept in reserve. The current is generated at 2,000 volts and transformed to 200 volts for distribution. Ample space is provided for doubling the whole of the plant, if necessary. The charge for energy is 7d. and 2d., on the maximum demand system.

Spain.—The Sociedad Minera de Mercadal has lately put down an electric power plant at its iron ore and calamine mines near Torrelavega, Spain. The water-power of a fall on the River Besaya is utilised, the power generated being used to drive the ore-washing plant and for the operation of three electric locomotives, which are at present hauling about 1,000 tons of ore per day.

A project is under consideration to put down a plant to utilise a waterfall about 10 kilometres from Ferrol, in the generation of electric energy for lighting purposes in the town and arsenal of Ferrol.

Sudbury.—The T.C. has decided to proceed with the electric lighting of the town at a cost not to exceed £12,000. Mr. W. C. C. Hawtayne is the consulting engineer.

Whitehead (Co. Antrim).—At a public meeting of the ratepayers of Whitehead on 17th inst., steps were taken to promote a limited company for the purpose of lighting the town with electricity. A committee was appointed to take charge of the matter. Whitehead is a rising town on Belfast Lough, about eight miles from Belfast.

ELECTRIC TRACTION NOTES.

Birkdale.—On Friday evening (21st) the D.C. gave their consent to a recommendation that the Southport Tramways Company should be empowered to take electric power from the Southport Corporation for traction purposes. A trial run will take place over the line from Lalworth Road to Birkdale Station, and the Board of Trade inspection was to take place on Wednesday (26th). The supply of power from the Southport Corporation will be continued till June 30th, when it is anticipated the generating station in Shaftesbury Road will be able to supply.

Bournemouth.—On 10th inst. a light railways inquiry was held at Bournemouth respecting the application of the Poole and District E.T. Company for an order for an extension of their existing line from Bourne Valley Pottery through Parkestone proper to the junction at Brown Bottom Corner. Mr. S. Morse, for the promoters, said that the line would be 1 mile 6 furlongs long, and on a 3 ft. 6 in. gauge, worked on the trolley system. Road widenings are proposed at three places. Evidence having been given in support of the scheme, voice was given to the opposition of the railway companies and of property owners.

Bridlington.—The B. of T. has granted an extension for six months of the order for the Bridlington and Flamborough Light Railway, on condition that the promoters at the end of six months are able to carry out the order.

Canada.—The largest electric railway project yet launched in Canada was sanctioned by the Railway Committee of the Ontario Legislature when the Cornwall and Toronto Bill, providing for the building of a line along the lake front from Cornwall to Toronto, came up for consideration. The company proposes to build a trunk line 350 miles long, and branches at various points, including one from Brockville to Ottawa as far as 30 miles back from the main line.

Carshalton.—The U.D.C. is supporting the B.E.T. Company's tramway scheme on the various grounds of cleanliness, reduced rates, and improved roads.

Dundee.—The Tramway Committee has resolved to expend £9,000 on the extension of the electrical station.

Isle of Man.—It is reported at Liverpool that a new company will shortly be placed before the public, formed for the purpose of taking over the electric tramways between Douglas and Laxey, Ramsey, and Snaefell. Mr. Ernest Schenk, of London, will be the managing director.

Liverpool.—A Coroner's inquiry took place at Liverpool on Saturday, respecting the death of a child named Welch, aged six years, who was knocked down by a tramcar and killed when crossing the road in Heyworth Street on the previous Thursday evening. Mr. R. C. Bellamy, general manager of the Liverpool electric tramways, who was called with other witnesses, stated that the life guard on the car was of the kind known as the "shelf" guard. It was composed of wire netting, so arranged as to lift obstructions off the track. It had been found a very effective guard. That was the first accident of the kind which there had been since May of last year, and during the time, guards of that class had proved effective in 31 cases in which persons had been saved from injury or destruction by means of it. The Coroner remarked that the car was liable to jump, and asked if that would not raise the front of the lifeguard, and allow the child to fall underneath. Mr. Bellamy replied that it was so. That was one objection to the guard, and the Tramways Committee had decided to change it. A hundred of the cars were now fitted with what was known as the "plough" guard, and the fitting of another hundred cars with the guard was proceeding. In his judgment, witness believed that any guard designed for picking up a body would fail occasionally. He thought the plough the best, for with it, it would be impossible for anyone to get into the position in which the child had got. The plough would clear any obstruction from the track; at the same time the "shelf" guard had been approved by the Board of Trade. Since the accident in May last, the Liverpool electric tramways had carried nearly 90 millions of passengers with a mileage of nine millions, without any accident of the kind occurring. The jury returned a verdict of "Accidental death." They exonerated the driver from blame, and recommended that the "shelf" style of lifeguards should be speedily superseded on all cars.

Middlesex.—Last week an inquiry was held by the Light Railway Commissioners at Hounslow into an application by the London United Tramways, Limited, for certain additional lines in Middlesex. The proposed lines would form a north and south connection between the points of the main trunk lines of electric tramways radiating from Shepherd's Bush and Hammersmith, joining up Southall, Hounslow, Twickenham, and Hampton, and giving access to Sunbury and Hampton Court. Mr. Balfour Browne, K.C., who appeared for the promoters, said, says the *Times*, that the lines mentioned were struck out of a scheme submitted by the promoters last year in order that more complete estimates might be prepared as to the additional widenings. But the local authorities whose districts were traversed now refused to be bound by the agreements of last year, and demanded much additional expenditure on improvements, and the Middlesex County Council also demanded that the roads should be made 50 ft. wide throughout. In these circumstances the promoters must withdraw the Southall to Hounslow and Sunbury to Hampton lines, as the average cost per mile would be £75,000, which was quite prohibitive for tramways through rural districts. These sections of the line were therefore withdrawn. The connection of the Hounslow and Twickenham lines with Sunbury and Kempton Park was sanctioned, subject to the approval of the Board of Trade.

Middleton.—Major Druitt and Mr. Trotter made a B. of T. inspection of the Middleton and Chadderton tramways, owned by the B.E.T. Company, on Friday last. The whole length of the company's line in the Chadderton and Middleton townships is a little over 8 miles. The inspectors expressed satisfaction with the undertaking.

Royton.—The D.C. and the Crompton D.C., who are acting jointly with respect to their electricity and tramway schemes, have appointed Mr. R. P. Wilson, of Westminster, as their engineer.

Mr. More, jun., C.E., of Edinburgh, has been appointed to make a valuation of the Bury, Rochdale and Oldham Steam Tramway Company's undertaking with the idea of purchase. The company's trams run through the Royton district, and the D.C. have already obtained the necessary powers for the construction of electric tramways within the township.

Wallasey.—The second and third routes of the Wallasey electric tramways were opened on Wednesday last week by Mr. W. G. Ellery, chairman of the District Council, and the members of the Council. At the luncheon which followed, Dr. Napier, chairman of the Tramways Committee, said that Mr. Ellery had laid the first rail of the system on June 24th last, so they had completed most of the system well within nine months, and three weeks earlier than the stipulated time. The whole of the track had been laid by the Council, and this had saved a great deal both in time and expense, while the original estimates of Mr. Travers, their engineer, had not been exceeded. All materials had been purchased in this country, and he was sure none better could have been obtained anywhere. The principal contractors for the work have been Messrs. J. H. Vicars, Nottingham (buildings), Lancashire Dynamo and Motor Company, Limited (engines and dynamos), Dick, Kerr and Co. (cars), British Insulated Wire Company (cables), and R. W. Blackwell & Co. (overhead equipment).

West Bromwich.—The Corporation has received the B. of T. approval to the loan for the reconstruction and electrical equipment of the tramways.

TELEGRAPH AND TELEPHONE NOTES.

A Dutch-German Cable Scheme.—The *Times* correspondent at the Hague says that the Dutch Government has submitted for approval of the States-General a telegraphic convention with Germany providing for a joint subsidy for telegraph cables to the Dutch colonies in the Far East. It is proposed to connect Menado, in the Celebes, with the American cable which is to connect the West Coast of North America with the Philippine Islands, *viâ* the Pelew Islands, which will also be connected with Shanghai. The importance of the convention lies in the fact that communication will thereby be established with Europe by way of America, and by cables belonging to companies of various nationalities.

The Pacific Cable.—Reuter telegraphs from Wellington that the cable steamer *Anglia*, engaged in laying the Pacific cable, has reached Doubtless Bay, thus completing the Australia—New Zealand section of the line.

Telegraph Rates to the East.—It is stated that the German Post Office authorities have concluded an agreement with the German Marine Telegraph Company, the Indo-European Telegraph Company, and the other cable companies concerned in regard to a reduction in the rates charged for the transmission of Press messages between Germany and China. The new charge, which came into force on the 15th inst., amounts to 1s. 11d. per word, as compared with 5s. 9d. hitherto, and telegrams can only be forwarded *viâ* Emden, Vigo, Madras, or *viâ* Bushire and Madras.

Telegraphs to the Far East.—A Parliamentary paper was issued on Saturday containing the terms of the convention between the United Kingdom and Persia, extending the system of telegraphic communication between Europe and India through Persia. The convention, which was signed at Teheran on May 16th, 1901, provides that in addition to the present line of telegraph from Teheran to Bushire and submarine cable thence to India, already established in virtue of previous treaties, a three-wire line of telegraph should be constructed by the Persian Government from Kashan to the Baluchistan frontier, *viâ* Yezd and Kerman, traversing, wherever possible, inhabited districts. The *Times* says that the line is to be built under the direction and supervision of the British telegraph staff now controlling the international line in Persia. The Persian Government agrees to lease the use and the transit revenue of the line, which is its property, when complete, to the Indo-European Telegraph Department at a rental of 4 per cent. on the capital expended on its construction, three-quarters of such rental to be retained by the British Government, to recoup them for the advances made, and one-quarter, subject to a minimum of 25,000f., to be paid annually to the Persian Government in two half yearly instalments. It is understood that, should the Persian Government's quarter share of the rental exceed 25,000f., such excess should belong to the Persian Treasury. The maintenance of the line, including repairs and the appointment, control, and payment of the line guards, who must be Persian subjects, shall remain in the hands of the British director and staff, the cost being defrayed by the British Government. The duties of the telegraph inspectors and line guards are strictly confined to repairing and maintaining the line.

Wireless Telegraphy.—The *Express* quotes the Berlin correspondent of the *New York Herald* as stating that the German Emperor, in issuing the special order giving unstinted praise to the Slaby-Arco wireless telegraphic system, intended it as a reply to the alleged discourtesy of the Marconi officials on the Nantucket lightship, who, so the story goes, refused to pick up messages from the *Deutschland*, which was equipped with the Slaby-Arco system. The Imperial order further commands all vessels in the Navy to carry the Slaby-Arco system, and consequently the Marconi Company, which claims a monopoly of rights all over the Continent, will have to bring an action against the German Government should it be desirous of contesting the rights of the Slaby-Arco system.

The report that the Marconi station at Nantucket had refused to receive messages transmitted from the German liner *Deutschland* by the Slaby-Arco apparatus, and that in consequence the German Emperor has placed an embargo upon the use of the Marconi system, is declared to be incorrect. A News Agency says that the *Deutschland* tried to get into communication with the Nantucket installation, but that none of the messages sent out from the liner reached the lightship. Even if they had reached the lightship, the Marconi operators would not have sent on the messages or replied to them, as the controllers of the system think it desirable that there should be a uniform system of wireless telegraphy for all shipping purposes.

The Central News New York correspondent says that the steamship *Campania* on arriving there on 22nd inst. reported that in mid-ocean the *Campania* tried to reach by wireless signals the liner *Lucania*, which was passing towards England. The signals failed; but were caught by the steamship *Philadelphia*, which, acting as intermediary, transmitted several messages between the two Cunarders.

It is reported that preliminary investigations have been undertaken with the concurrence of the French Government by the "Société Français des Telegraphs sans Fil," with a view to the establishment of wireless telegraphic communication between Gabes, on the coast of Tunis, and the French possessions at Lake Chad.

The *Morning Advertiser* says that Marconi has selected Table Head, Glace Bay, as the site of his Nova Scotia station. On his informing the Town Council that the electric sparks from the tram trolley would injure his system, that body has guaranteed to keep the tram one-third of a mile from the proposed station for five years. Signor Marconi says that the station will be complete in three months, and that contracts have been awarded for its construction.

It is reported that Marconi has signed his contract with the Canadian Government.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barcelona.—April 7th. The Port and Docks Board of Barcelona will on this date consider tenders for supply and installation of machinery, geared by electricity for the loading and unloading of merchandise, and the establishment of the necessary conduits, as well as the installation of electric light.

Bedford.—April 3rd. 28 30-KW. alternating current transformers for the Corporation. See "Official Notices" March 21st.

Bermondsey.—April 14th. Arc lamp columns, meters, oils, incandescent lamps, cables, meter-boards and stores for the electricity and destructor works. See "Official Notices" to-day.

Bexley.—April 21st and 28th. Tram rails, fishplates, &c. also engines, alternators, and dynamos, for the U.D.C. See "Official Notices" to-day.

Devonport.—April 16th. Permanent way, bonding, &c., for over three miles of track for the Corporation. See "Official Notices" March 14th.

Edinburgh.—March 31st. Arc lamp carbons, cast-iron pipes, also road box frames, covers, &c. See "Official Notices" March 14th.

Falkirk.—April 12th. Three 100-KW. steam dynamos (vertical enclosed high speed engines) for the electricity scheme. See "Official Notices" to-day.

Hackney.—April 9th. Three water-tube boilers, water softener, &c., for the electricity works. See "Official Notices" February 28th.

Italy.—April 8th. Tenders are being invited until April 8th by the municipal authorities of Maddaloni (province of Caserta) for the establishment of a central electric lighting station in the town.

London.—April 23rd. High and low-pressure switchboards at the Grove Road generating station of the Central Electric Supply Company. See "Official Notices" to-day.

Maidenhead.—April 4th. "Easy wiring" proposals are wanted by the E.L. Committee. See "Official Notices" March 21st.

Manchester.—April 10th. Coal and ash conveyors for the electricity department. See "Official Notices" to-day.

Oldham.—April 9th. Electrical equipment of the new car depôt at Wallshaw for the Corporation. See "Official Notices" to-day.

Penang.—April 28th. Boilers, condenser, pumps, pipes, steam dynamos and balancer booster, switchboards, batteries, cables, junction boxes, arc and glow lamps, posts and accessories, for the commissioners of George Town. See our "Official Notices" March 14th.

Rathmines.—April 24th. 300-KW. steam dynamo, switchboard and mains. See "Official Notices" March 21st.

Rochdale.—April 8th. "Free or assisted" wiring proposals are wanted by the Corporation. See "Official Notices" to-day.

Rockhampton (Australia).—March 31st. The Council of the Municipality of Rockhampton is prepared to consider applications from companies desirous of undertaking the construction and working of a system of electric tramways under the Queensland Tramways Act of 1882, and the Amendment Act of 1890. See ELECTRICAL REVIEW, January 10th.

Rotherham.—April 23rd. Rolling stock, overhead work, and permanent way, for Corporation electric tramways. See "Official Notices" to-day.

Shipley.—April 2nd. Tenders are invited for an electric light installation at the Central Schools. See "Official Notices" March 21st.

Southampton.—April 5th. Boilers, mains, conduits, economiser, crane, and machine tools for the Electricity Department. See "Official Notices" March 21st.

Southend.—April 2nd. Electric wiring propositions are wanted by the Corporation. See "Official Notices" March 14th.

Southend.—April 3rd. 50 arc lamp columns for the Corporation. See "Official Notices" March 21st.

Spain.—April 1st. The Spanish Post and Telegraph authorities in Madrid are inviting tenders until April 1st for the supply of 136 tons of iron wire 4 mm. diameter, and 5 tons 5 mm. diameter. Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Correos y Telegrafos, Carretas 10, Madrid.

Spain.—April 3rd. The Spanish Post and Telegraph authorities are inviting tenders until April 3rd for the supply of 15 tons of copper wire. Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Correos y Telegrafos, 10, Carretas, Madrid.

Spain.—April 15th. The Spanish Post and Telegraph authorities in Madrid are inviting tenders until April 15th, for the supply of 30,000 zinc cylinders for telegraph purposes. Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Correos y Telegrafos, 10, Carretas, Madrid.

Spain.—April 20th. The *B. of T. Journal* last week contained notice of a call for tenders to take over and work the electric light installation of the town of Irún, which was unsuccessfully offered some months ago. Particulars at the B. of T. Offices.

Sydney.—May 7th. Messrs. Preece & Cardew, on behalf of the Municipal Council, invite tenders for equipment of electricity works and sub-stations. Water-tube boilers, three-phase steam alternators, battery, motor-generators, stationary transformers, switchboards, &c. See "Official Notices" March 21st.

Warrington.—April 9th. Steel rails and permanent way work, also overhead equipment for Corporation tramways. See "Official Notices" March 14th.

CLOSED.

Brighton. — "New London" dry-seat equipments have been ordered for 10 new cars by the Corporation. This makes 40 cars in all which the maker, Mr. Hu. Crichton, of Liverpool, has fitted with his seats at Brighton.

Coventry.—The E.L. Committee have placed an order with Messrs. J. and H. Maclaren, for an additional 1,000-H.P. engine, and with the British Schuckert Electric Company, for an additional 600-KW. two-phase alternator, at prices not exceeding £4,275 and £1,580 respectively.

France.—The French Post and Telegraph authorities in Paris have just placed contracts as follows:—La Société d'Electro-Metallurgie de Dives, 25 tons of bronze wire, $\frac{1}{10}$th mm. diameter, and 40 tons of copper wire, 4½ mm. diameter; La Compagnie des Trefileries du Havre, 25 tons of bronze wire, $\frac{1}{10}$th mm. diameter, and 80 tons of copper wire, 4½ mm. diameter; La Compagnie Française des Métaux, of Paris, 30 tons of bronze wire, 1½ mm. diameter, and 40 tons of copper wire 4½ mm. diameter; La Compagnie Générale d'Electricité, Paris, 30 tons of copper wire, 2 mm. diameter; M. Grammont, of Pont de Cheruy (Isère), 40 tons of copper wire, 4½ mm. diameter; and La Compagnie Française du Bi-Metal, Paris, 10 tons of copper wire, 1 mm. diameter, and 10 tons ditto, 2 mm. diameter.

Liverpool.—The Corporations of Liverpool and Blackburn have awarded their contracts for rubber wires for the next financial year to the St. Helens Cable Company, Limited.

Oban.—The T.C. has accepted the offer of Messrs. MacKenzie Bros., Edinburgh, to supply arc lamp-posts for £11 each.

Stepney.—The following is a list of the tenders sent in to the Borough Council for supplying and fixing a complete electric light installation at the Public Library, Bancroft Road, Mile End, E. Mr. M. W. Jameson, borough engineer:—

Barlow Bros.	£127	0	0
Christie & Co.	96	0	0
Haines & Co.	148	18	8
Tamplin & Makocski	109	17	2
The Lighting Corporation, Limited	107	10	0
Ward Bros. (accepted)	93	1	0

London.—Messrs. Cryselco, Limited, of Bedford, have again been entrusted with the contract for the whole of the lamps required for the opera season at the Royal Opera House, Covent Garden.

London.—The London County Council has received the following tenders for the supply of 1,000,000 stoneware ducts for the accommodation of the cables required in connection with the proposed electric tramways:—

	Per 1,000 ducts.			Amount of tender.		
Stanley Bros, Ltd., Nuneaton	£18	5	0	£9,125	0	
				(For 500,000 only.)		
G. Skey & Co., Ltd., Tamworth	18	5	0	18,250	0	0
H. R. Mansfield, Burton-on-Trent	18	5	0	18,250	0	0
Sutton & Co., Ashby-de-la-Zouche	18	7	6	18,875	0	0
T. Wragg & Sons, Ltd., Swadlincote	18	7	6	18,875	0	0
Boothorpe Pipe Co., Burton-on-Trent	19	0	0	19,000	0	0
Ashgrove Brick, Tile and Fireclay Co., Elland, Yorks.	20	0	0	20,000	0	0
Ensor & Co., Ltd., Burton-on-Trent	20	0	0	20,000	0	0
James Stiff & Sons, Lambeth	21	0	0	21,000	0	
Leeds Fireclay Co., Ltd. (E. Brooke & Sons' Branch), Huddersfield	25	0	0	25,000	0	0
Geo. Jennings, Ltd., Lambeth	25	0	0	25,000	0	0
Joseph Place & Sons, Ltd., Darwen	28	2	6	28,125	0	
Oates & Green, Ltd., Halifax	32	0	0	32,000	0	0
Leeds Fireclay Co., Ltd. (W. Ingham & Sons, Ltd., Branch), Wortley	31	0	0	32,000	0	0
Albion Clay Co., Ltd., Burton-on-Trent	35	0	0	35,000	0	0
Hamblet's Blue Brick Co, Ltd., West Bromwich	36	9	2	36,458	6	8
Sharp, Jones & Co., Parkstone, Dorset	37	10	0	37,500	0	0
Hosea Tugby & Co., Ltd., Ashby-de-la-Zouche	41	13	2	41,666	13	4

The Highways Committee in reporting on the subject, states that the rate per 1,000 of the three first tenders is the same, and that the sample ducts submitted, and times of delivery specified are satisfactory, and they express the opinion that each of the firms should supply a portion of the ducts required. Although the three samples are satisfactory, the committee are advised that that of Messrs. Skey appears to be the best, and they think that the largest portion of the contract should be entrusted to that company. The Committee, therefore, recommend the Council to accept the tender of Messrs. Skey & Co., for 500,000 ducts for £9,125, and those of Messrs. Stanley Bros., and Mr. H. R. Mansfield, each for 250,000 ducts for the sum of £4,562 10s. The Council on Tuesday accepted the tenders referred to.

NOTES.

Electricity Works Statistics.—With this number of the ELECTRICAL REVIEW our readers will receive the first portion of our annual sheet of statistics regarding the electricity works of the United Kingdom. The second moiety will follow next week, and we reserve our comments till then.

Law *v.* Justice. — The case to which one of our correspondents draws attention on another page, is one which calls for the close consideration of all who are interested in the maintenance of a high standard of commercial morality. Here is a clear promise to pay certain moneys, made before a witness, and not only admitted by the defendant, but recognised by a jury, and by four distinguished judges. Yet the judges of the Appeal Court are obliged regretfully to rule that the promise is not binding, because, forsooth, it was not put in writing! An Englishman's word used to be as good as his bond; we trust that the time may be far distant when such cases as this will be anything but the rare exception. But why is this absurd enactment, embodied in the Statute of Frauds, perpetuated? In many other instances—for example, in indemnity cases, the promise before a witness is binding; and in actions for breach of promise of marriage, even the witness is unnecessary! We do not go so far as to suggest that the latter should be taken as a precedent; we must guard against dishonesty on the part also of the person to whom the promise is made. But, while it were always preferable that promises of this nature should be reduced to writing, it ought not, under any circumstances, to be possible for a man to escape from the fulfilment of a verbal promise, duly witnessed, and recognised by a jury.

Manufacture of Pure Calcium Carbide.—A German patent (No. 125,208) has been taken out by Drs. Zühl and Eisenmann, of Berlin, for the manufacture of a calcium carbide which shall yield acetylene free from sulphur and phosphorus. The lime and coke separately, or the mixture thereof, is treated with a solution of a compound of some heavy metal, such as chromium, tungsten, tin, or lead; the proportion taken being calculated according to the amount of impurity in the raw materials. When the whole is heated in the electric furnace the sulphur and phosphorus combine with these heavy metals, and the gas finally liberated from the carbide is said to be sufficiently pure to be burnt domestically without special purification.

Business Announcement.—After being unrepresented in London for several years, Messrs. Paterson, Cooper & Co., Limited, of Paisley, have just opened an office at 57, Gracechurch Street, E.C., where Mr. J. Walter Brown, A.M.I.C.E., will represent them.

Personal.—Mr. T. H. Minshall, the late manager of the Croydon lighting and tramway works, is now engaged in private practice at 28, Victoria Street, S.W.

The Yarmouth T.C. have appointed Mr. F. L. Turner, traffic superintendent to the Corporation of Blackpool, to be traffic manager for the new tramway system, at a salary of £150 per annum, rising to £200.

Electricity in Buildings.—On February 10th Mr. A. H. Dykes, A.M.I.C.E., read a paper before the Bristol Society of Architects on this subject. The various methods of wiring were described, the advantages and otherwise of each system being pointed out. Notwithstanding his advocacy of screwed-iron pipe work, the author gave instances of what has no doubt been the experience of many who have had much to do with this class of work, viz., that under certain conditions, iron-pipe work is one of the most unsatisfactory forms of wiring it is possible to put up. In places subject to considerable variations in temperature, the condensation inside the pipes very soon ruins the insulation on the wires. No mention appears to be made of the internally-lined pipe, which it is claimed prevents condensation by maintaining a practically uniform temperature inside the pipe. A system of wiring in brass tubing was described as being devised by the author, and is giving satisfactory results. Brass tubing systems were used at least 10 years ago, probably earlier. We call to mind a system devised and patented by Smythe and Payne, in which the inner conductor was a bare wire, having threaded on it a number of glass beads, insulating it from the tube, which formed the return. The system was worked out in great detail, and many installations were wired in this way. In offices and banks, the tubes were so arranged as to form book racks, &c., and so served a double purpose. Attention is called by the author to the fact that by the adoption of motor driving, the architectural features of works may be considerably modified, that is, as regards the general arrangement. Thus a mill, instead of being built in four or five stories, as is necessary when the machinery is driven by ropes from one main engine, may be built in one storey on the shed principle, when electric driving is adopted.

Lectures.—A lecture on "The Electric Driving of Workshops" was delivered by Mr. Ellis H. Crapper (lecturer in electrical engineering in the University College) to the Sheffield Society of Engineers and Metallurgists the other day.

"The Municipal Electric Service" was the title of the Glasgow Corporation popular lecture delivered on 13th inst. by Mr. W. A. Chamen.

Mr. R. Matthews read a paper on "Efficiencies of Electric Cranes" at a meeting of the Manchester Association of Engineers on 8th inst.

Before the East of Scotland Engineering Association, at Edinburgh, Mr. R. W. Hogarth read a paper on "Gas-driven Electricity Stations."

The Glasgow Switchboard Accident.—A claim for compensation under the Workmen's Compensation Act was heard before Sheriff Boyd on 18th inst. The father of the man Stannage, who was killed by shock last November at the Pinkston generating station of the tramways department, was the claimant, and sued the Glasgow Corporation accordingly. (The details of the accident were recorded in the ELECTRICAL REVIEW at the time.) The Sheriff found that defenders' station was not a factory within the meaning of the 1895 and 1897 Acts, and assoilzied defenders accordingly. "Electrical stations" are, however, included in the 1901 Act, which came into force on January 1st, 1902, and he found pursuer liable to expenses reduced to 2 guineas.

How to Settle a Difference.—As electrical engineers have from time to time taken great interest in refuse destructors, we reproduce the following from the *Globe* of the 20th inst.:—"The Kettering School Board and the Urban Council having been at cross purposes with regard to the site of a refuse destructor, a friendly game of golf was arranged and played at the Kettering links. The Urban Councillors were victorious, and claim (says *Golfing*) that the School Board ought to withdraw their opposition." If this plan of settlement were adopted in all disputes on electrical matters, experts would enjoy better health, although fees might be considerably reduced.

500-Volt Shocks.—With reference to the discussion on Mr. Trotter's paper, a correspondent has been good enough to forward us the following from *Pearson's Weekly*. As we said in our issue of March 14th, this is just the sort of thing we had to fear from the "sensational modern journalist":—

"LIVE WIRES WON'T HURT.

It is generally supposed that electric shocks at 500 volts will invariably prove fatal, but that such is not the case was proved the other day by a member of the Institution of Electrical Engineers, who stated that even with wetted boots he had stood on the rails of the City and South London Railway, sat on the live conductor and slapped the running rails with bare hands. He further said that, provided the day were dry and the skin not moist, it was quite safe for the average person to handle live wires. One man fell on a cable carrying a current of 5,000 volts, and escaped with only a few burns. Another man was rendered unconscious by a 2,000-volt current, but was soon restored unhurt. A 100-volt current has been known to cause death, but such a case is quite a rare occurrence."

City and South London Railway.—Last Saturday morning a delay of about four hours occurred on this railway. We understand that a cable leading from one of the machines to the switchboard at the generating station developed a short between the core and the sheathing, caught fire, and the flames travelling up behind the board, it became necessary to shut off the current and put the hose on. The accident itself did not last more than about five minutes, but the work of drying and testing and getting things right again necessarily occupied some time. The fire would not have spread seriously but for the inflammable covering of the cable. Coming so soon after Mr. Clothier's paper pointing out the danger of switchboards with cable connections, and Mr. Trotter's report on the Liverpool overhead railway fire, the occurrence is particularly noteworthy. The need for cables insulated with incombustible materials is emphasised by this regrettable mishap.

Institution of Electrical Engineers (Students).—The following is the programme of the visit to the Newcastle-on-Tyne district arranged for the Students' Section of the Institution. Each of the visits is necessarily restricted to *students* of the Institution, and only to those who shall have sent in their names before April 2nd to the hon. secretary of the Students' Section:—

Tuesday, April 8th—
9.30 a.m.—The works and sub-stations of the Newcastle Electric Supply Company.
2.30 p.m.—The works of the Sunbeam Electric Lamp Company.

Wednesday, April 9th—
9.30 a.m.—The works of Messrs. Ernest Scott & Mountain.
2.30 p.m.—The Elswick Works of Sir W. G. Armstrong, Whitworth & Co.

Thursday, April 10th—
9.30 a.m.—The Sunderland Corporation electric light and tramway system.
11.30 a.m.—The works of the Sunderland Forge and Engineering Company.
3.15 p.m.—The works of Messrs. J. H. Holmes & Co.

Friday, April 11th—
10 a.m.—The three-phase tramway system at Stockton-on-Tees.
12 noon.—The Stockton-on-Tees Corporation Electricity Works.
3.30 p.m.—The Forth Bank Works of the Newcastle and District Electric Lighting Company.

Saturday, April 12th—
10 a.m.—The works of Messrs. Palmer's Shipbuilding and Iron Company.

The party will arrive in Newcastle on Monday evening, April 7th, in time to attend the meeting of the Newcastle Local Section, to be held at the Durham College of Science, at 7.30 p.m.

Appointment Vacant.—Electrical engineer at £300 per annum for the Wakefield Corporation.

Electrical Standardizing, Testing and Training Institution.—Increased accommodation having been obtained at Faraday House, the Board have made arrangements to commence a new session at the beginning of the summer term, *i.e.*, on Monday, April 7th. The entrance examination will be held at 11 a.m. on Wednesday, April 2nd.

Petty Tyranny.—A remarkable clause occurs in the "application schedule" issued by the Glasgow Corporation Tramways Department, which is altogether a most inquisitorial document. Every man employed by the department in the receipt of £250 or less, is compelled, we believe, to subscribe to the following charter of liberty:—

"It is a condition of any employment with the GLASGOW CORPORATION TRAMWAYS that any Employé may at any time be dismissed from the Service without previous notice or reason being given, and any Employé may leave the Service at the end of his day's work, without giving any previous notice, and the present application is made in the Applicant's knowledge of this condition."

That such a clause should be imposed by a soul-less, money-making, monopolising company of human beings, would be sufficiently startling; but that a famous Municipality, in the intervals of housing the poor and putting a penny on the rates, should perpetrate such an oppressive and inhuman instrument of tyranny can only be described as astounding. What would happen if some day the whole of the staff should avail themselves of their valuable right to depart without notice?

Energy from Refuse.—Some remarkable results have been achieved recently from refuse destructors. We recently published (ELEC. REV., Jan. 10th, 1902, p. 66), an abstract of the performance of the Meldrum destructors and Babcock boilers at Wrexham; 38 Board of Trade units of energy having been generated on an average throughout December last year from every ton of refuse. Similar results were shown during January last; according to a log-sheet which we received last month from Mr. W. Sillery, borough electrical engineer, the whole of the electricity, from December 28th to February 1st, was generated entirely from refuse, and steam was also supplied to all the auxiliary plant, not a pound of coal being used. Particulars of the operation of the Horsfall refuse destructor at Accrington, in conjunction with a Lancashire boiler, for the month of November last, have just come to hand, and are no less interesting. The output per day was a little more than at Wrexham, the total for the month being 18,796 units generated from 2,132,256 lbs. of refuse, or nearly 20 units per ton. The maximum load was 111 KW., and the greatest output in one day 1,039 units generated, the average being 783 units per day. Steam was also supplied for pumps, forced draught, &c., and no fuel other than refuse was required. The plant is in the charge of the borough engineer, Mr. W. J. Newton, and the borough electrical engineer, Mr. H. Gray, from whose data we have abstracted the figures given above.

London County Council.—The Council, at the meeting on 18th inst., resolved to lend £15,400 to the Poplar Borough Council for electric lighting purposes, and £10,438 to the Islington Council for expenditure on the Eden Grove generating station.

The Tramway Manager.—The General Purposes Committee reported having received a memorandum from the Highways Committee drawing attention to the anomalous position of Mr. A. Baker, the tramway manager. When Mr. Young declined to accept the position offered him, the Committee pointed out that Mr. Baker was appointed manager of the undertaking, and to advise the Council generally on matters connected with the tramways. The position of chief officer of tramways had therefore not yet been technically filled, and as the Highways Committee had found it necessary to consult Mr. Baker on many matters quite beyond the scope of his duties as manager, and as the tramway business had increased, the Committee were of opinion that the time had arrived for the recognition of the manager as head of a department. The Committee concurred in the suggestion, and on their recommendation, the Council resolved that Mr. Baker should be chief officer of the tramway department.

A Continental Inquiry.—The opinion was expressed by the Highways Committee that the tramway manager and the electrical engineer should, during the Easter vacation, make an examination of the actual working conditions of the shallow underground system of tramways in operation in Paris and Buda-Pesth, and of the systems of electric traction, especially the surface contact method, in use in those cities and in Munich. The Committee recommended the Council to sanction an expenditure of £100 for travelling and other expenses in connection with the visit of the two officials. After a brief discussion the recommendation was carried with the inclusion of Berlin within the scope of the projected investigation.

The Lewisham Company.—The Highways Committee announced that three notices had been received from the Lewisham and District Electric Supply Company of intention to lay high and low pressure mains in High Street, Lewisham, and along Rushey Green and Catford Road. The company had no generating station within the area of supply under the order, and the Committee had no reliable information as to whence the company would obtain a supply of electrical energy for the mains referred to in the notices. In the circumstances, the Committee considered that the Council should withhold its approval of the works, and a recommendation was carried deciding not to sanction the laying of the mains.

The Overhead Trolley System.—Mr. M. Beachcroft moved that the Highways Committee should be instructed to consider and report on the following points:—

(1) As to the cost of construction per mile of single track (exclusive of cars and power stations) of a tramway on the overhead system as compared with the conduit. (2) As to the saving, if any, in working expenses and time occupied in construction, in the one system, as compared with the other. (3) As to the objections, if any, to a mixed system of overhead and underground traction, and the practicability of an exchange between the two systems. (4) Whether, inasmuch as the overhead system will inevitably prevail outside the County of London, there is any solid reason why the Council should not adopt the overhead system inside the county in those districts which are sufficiently removed from the crowded centre of London, and where the local authorities concerned do not object.

In proposing the motion, the speaker said that although he did not suggest that the Council should adopt the overhead system, it was desirable for the members to have particulars of the cost and relative advantages placed before them, especially as some of the local authorities—as for instance, Camberwell and Hammersmith—would rather have the overhead system than nothing for the present.

Mr. J. R. Cousins, who seconded the motion, was followed by Mr. Parker, who opposed it, and stated that a reference on similar lines had already been moved to the electrical engineer, and that the Council would doubtless have in his report the details that were desired.

Mr. J. A. Baker expressed the hope that the Council would not accept the motion, as it would take up a great deal of the officials' time unnecessarily. Besides, the Council had already had two or three valuable reports on the subject, and the difference between the cost of the two systems was about £2,000 per mile of track.

After further discussion, the motion, for which eleven votes were recorded, was rejected by a large majority.

A New Appointment.—The Highways Committee stated that in consequence of the large amount of work devolving upon the electrical engineer at the head office, it had been necessary to afford him the assistance of a mechanical draughtsman at £4 per week. There was no prospect of the work decreasing, but on the other hand, a very large increase was anticipated, and the Committee were, therefore, of opinion that an official of that description should be added to the permanent staff. On the recommendation of the Committee it was decided to appoint a draughtsman in the first-class at a commencing salary of £215 per annum, and to issue advertisements inviting applications for the position.

Prof. S. P. Thompson and the Patent Law.—We have drawn attention, on page 499, to a letter addressed by Prof. S. P. Thompson to the *Times*. In this there is a reference to Prof. Hughes and the microphone. The Professor's classical paper was communicated to the Royal Society on May 8th, 1878, and concludes thus:—"I do not intend to take out a patent, as the facts I have mentioned belong more to the domain of discovery than invention. No doubt inventors will ere long improve on the form and materials employed. I have already my reward in being allowed to submit my researches to the Royal Society."

Electro-Harmonic Society. — The next and final smoking concert of the season will be held on Friday evening, April 11th, instead of on March 28th.

Correction.—In our "Stocks and Shares" article last week we stated that the close price of Electric Construction Company's shares was lower "consequent upon dissensions upon the board." We are, however, informed that this statement is quite devoid of foundation.

Address Wanted.—Will "R. E.," who lately inquired *re* a jig for dynamo brushes, kindly communicate with us?—Eds.

THE CENTRAL STATION ENGINEER.

Another of the series of smoking concerts arranged by the Brighton Electricity Department was held on Monday evening last week at the Unicorn Hotel, North Street, the company consisting of members from the Tramways and Electricity Departments. Mr. J. Christie presided.

Mr. L. H. King, mains superintendent at Bexhill, has been appointed chief assistant at Whitby.

The Oban T.C. has appointed Mr. M. P. Plunkett to the post of resident electrical engineer at a salary of £150 per annum.

NEW COMPANIES REGISTERED.

Burnand Transformer Company, Limited (73,049).—This company was registered on March 11th, with a capital of £6,000 in £1 shares, to carry on the business of transformer makers for electrical purposes, wire rope makers, wire drawers, galvanisers, japanners, annealers, enamellers, founders, metal workers, fitters, metallurgists, electric light and power engineers, suppliers of electricity, electricians, electrical and mechanical engineers, &c., and to adopt an agreement with W. E. Burnand, F. E. Procter and E. Cottrill. The first subscribers (each with one share) are:—F. E. Procter, Cromford Court, Manchester, electrical engineer; W. E. Burnand, 124, Oakbrook Road, Sheffield, electrician: E. Cottrill, Cromford Court, Manchester, electrical engineer; P. Higson, 18, Booth Street, Manchester, mining engineer; G. Bateman, 52, Alwyn Road, Fallowfield, electrical engineer; M. W. Hydes, Finch House, West Derby, Liverpool, rubber merchant; and B. Ellis, 2, Victoria Street, Manchester, land agent. Minimum cash subscription, £1,000. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers; qualification, £200; remuneration as fixed by the company.

European Electric Railways and Public Works Construction Company, Limited (73,051).—This company was registered on March 11th, with a capital of £21,000 in £1 shares, to carry on the business of contractors for public and other works, mechanical and civil engineers, constructors of electrical and other railways, tramways, tube railways, docks, harbours, piers, tunnels, bridges and the like, manufacturers of rolling stock, &c. The first subscribers (each with one share) are:—A. Quick, 4, Bishopsgate Street, E.C., colonial agent; C. J. Biggs, 150, The Portway, West Ham, secretary; A. Knopwood, Watton, Norfolk, merchant; S. E. Spencer, 52, Great Marylebone Street, W., accountant; J. G. Garson, 14, Stratford Place, W., physician; T. E. King, 1, Victoria Cottages, Albert Street, Mile End New Town, accountant; A. J. Scrutton, 194, Pelham Street, E., warehouseman: and H. Bacon, 147, High Street, West Norwood, secretary. No initial public issue. The number of directors is not to be less than two nor more than 10; the subscribers are to appoint the first; qualification, 1 share; remuneration, £150 each per annum, and £100 extra for the chairman.

Kalgoorlie Electric Tramways, Limited (73,127).—This company was registered on March 18th, with a capital of £250,000 in £1 shares, to acquire concessions, rights and privileges for the construction of tramways and railways in Australia and elsewhere, to construct and equip such tramways and railways, and to carry on the business of carriers of passengers and goods, electrical engineers, electricans, engineers, contractors, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic and other apparatus, suppliers of electricity, &c. The first subscribers (each with one share) are:—A. H. P. Stoneham, 29, St. Swithin's Lane, E.C., managing director of West Australian Gold Fields, Limited; O. Wethered, 30-31, St. Swithin's Lane, E.C., chairman of Hampton Plains Estate, Limited; C. Woln, 28-29. St. Swithin's Lane, E.C., managing director of Tramways Syndicate, Limited; R. C. Ogilvie, Broad Street House, E.C., director of London and West Australian Exploration Company, Limited; E. Hensman, Suffolk House, Cannon Street, E.C., chairman of Perth Electric Tramways (W.A.); C. C. Baker, 139, Cannon Street, E.C., director of Colonial Consolidated Finance Corporation, Limited; and E. Hooper, Salisbury House, London Wall, E.C., mining engineer. No inital public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £250; remuneration, £150 each per annum, and £100 extra for the chairman.

Delimco, Limited (2,650).—This company was registered in Dublin on March 21st, with a capital of £2,000 in £1 shares, to carry on the business of electrical engineers, now carried on at 157, Upper Rathmines, Dublin, by G. Wallace and C. Findlater, under the style of "The Modern Electric Appliance Company." The first subscribers (each with one share) are:—W. Graham, 83, Harcourt Street, Dublin, gentleman; J. H. M'Crea, Wood Street, Dublin, merchant; H. Grandy, Templeville, Templeogue, merchant; J. Eurelle, 39, Great Brunswick Street, Dublin, gentleman; M. Good, 5, Dawson Street, Dublin, solicitor, LL.D.; G. Wallace, 151, Upper Rathmines, Dublin, electrician; and C. A. Findlater, 5, Dawson Street, Dublin, engineer. The number of directors is not to be less than three nor more than eight; the first are W. Graham, H. Grandy, G. M'Crea and C. Findlater qualification £1.

SUPPLY STATION ACCOUNTS.

Manchester Corporation Electricity Accounts.

The last issued accounts of the Manchester Corporation electricity department show a total output of 9,639,973 units, of which 7,944,540 were measured and accounted for. The loss on distribution was 17 58 per cent. At the time of issue of the report, regret was expressed that owing to delay in equipping the new Bloom Street station, applications from consumers were postponed until it should be evident that plant would be available to meet the demand for supply. This, coupled with the large increase in capital

expenditure on mains, part of which only was really productive, led to the accounts having a less favourable financial aspect compared with those previously presented. The capital expenditure contemplated at the time the accounts were presented represented a sum of no less than £810,110, covered by Local Government Board sanction.

General Statement.

	1899.	1900.	Inc.
Total capital expenditure ...	£641,822	**£863,293**	£221,471
Number of units sold	6,355,872	**7,794,098**	1,438,226
No. of 8-c.p. incand. connected ...	237,145	**279,860**	42,715
Number of arc lamps connected...	2,139	**2,316**	177
Number of motors connected ...	500	**672**	172
Maximum load in kilowatts ...	5,607	**6,876**	1,269
Gross revenue	£85,832	**£101,776**	£15,944
Gross expenditure...	£49,439	**£58,827**	£9,388
Gross profit	£36,393	**£42,949**	£6,556
Average price per unit sold ...	3·23d.	**3·106d.**	−·124d.

The consumers numbered 3,790, being an increase of 550. In the above statement the number of lamps (arc and incandescent) and motors connected to the mains is given. The latter aggregated 6,560 h.p., of which 4,510 h.p. were connected during the financial year. The total mileage of mains laid was 159 miles 485 yards, or an increase of nearly 50 miles in 12 months, which accounts for the opinions expressed by the Council as to the position of the undertaking, a matter already dealt with in our columns.

Revenue Statement.

	1899. Gross	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Sale of energy	£85,544	3·23d.	**£100,869**	3·106d.	−·124d.
Meter rents	184	·01d.	**230**	·007d.	−·003d.
Sale of materials	—	—	—	—	—
Sundry rents, and interest received.	104	·00d.	**677**	·021d.	+·021d.
Gross revenue ...	£85,832	3·24d.	**£101,776**	3·124d.	−·106d.

Coming to the financial statements of revenue and expenditure, it will be noted that the receipts from the sale of energy have fallen by ¼d., and now stand at just over $3\frac{1}{16}$d. The cost of production has been reduced by a little less than half this amount. The only serious increase is in the establishment charges, of which a large proportion is due to Law and Parliamentary costs, amounting to £2,189. Had these special expenses not been incurred (or had it been considered advisable to regard them as capital charges) the reduction in costs would have been about equivalent to the fall in receipts.

Cost of Production.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Coal (and unloading same)	£10,376	·39d.	£14,315	**·440d.**	+·050d.
Oil, waste, water, and engine room stores.	3,883	·15d.	3,567	**·110d.**	−·040d.
Salaries and wages incurred in generation and distribution.	6,353	·24d.	6,361	**·196 l.**	−·044d.
Repairs and maintenance of engine, boilers, dynamos, buildings, &c.	14,176	·53d.	15,479	**·477d.**	−·053d.
Works costs ...	£34,788	1·31d.	£39,722	**1·223d.**	−·087d.
Rent, rates and taxes ..	6,516	·25d.	7,018	**·216d.**	−·034d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	4,856	·19d.	6,220	**·192d.**	+·002d.
General establishment charges, stationery and printing, law charges and insurance.	2,656	·10d.	5,048	**·156d.**	+·056d.
Other expenses: Bank commission, thrift fund, and commission on loans.	623	·02d.	819	**·025d.**	+·005d.
Total costs ...	£49,439	1·87d.	£58,827	**1·812d.**	−·058d.

The gross profit increased by £6,556. Against this, however, there were financial charges, which required an additional sum of £11,884 to cover the annual amounts. The difference of £5,328 had therefore to be met by a reduction in the net profits from £9,193 to £3,865. According to the expectations of the Committee, there will be at the end of the current financial year no net profits to transfer to the general rate account, but when the new generating stations are fully at work, and the mains in the outlying districts begin to bring in a reasonable revenue, Manchester should again return to days of prosperity.

Profit Statement.

	1899.	1900.
Interest on loans, deposit, and bank overdraft..	£14,265	£20,479
Sinking fund for repayments	12,935	18,605
Net profit carried forward to reserve fund	—	349
" " to credit of local rates	9,193	3,516
Gross profit	£36,393	£42,949

CITY NOTES.

London Electric Supply Corporation.

Mr. R. H. Benson presided on Thursday in last week over the ordinary general meeting of the shareholders of the London Electric Supply Corporation, Limited, held at Winchester House, E.C., and in moving the adoption of the report, first referred to the death of Lord Wantage, the chairman of the company, who, he said, when the reconstruction of the station was required, found the whole of the money. With regard to the accounts, if they turned to the gross revenue accounts, they would see that the figures were given for the years 1899 and 1900 along with the figures for 1901, and that was done in order to make a comparison easy. It would have been misleading to have given last year's figures only, because for seven months in 1900 the station at Deptford was closed for the complete overhauling of the machinery, and to enable new plant to be put in to meet normal and legitimate demands for light. Hence, in 1900 they had to buy current from other producers, and naturally had to pay a price which left the profit to them and not to the company. Moreover, the shut-down at Deptford involved a temporary decrease in the number of customers. Now that was all changed. The machinery was running perfectly, and the quality of their product was of the highest. By December 31st last they had practically regained all lost ground, and all but reached the record year of 1899. They would observe that the gross revenue last year was £71,167 against £72,902 in 1899; but when they came to the net revenue, it was no less than £25,200 last year, against £21,518 in 1899. But that was not all; for in consequence of the improvement in the machinery, the tendency continued for receipts to increase, and for expenses to decrease, while their customers steadily increased. For the current quarter of the year 1892 it looked as if they would have £10,500 net against only £8,529 in the corresponding quarter of last year, and for the full year, if he might venture to prophesy, he thought they would have over £30,000 net, or more, against £25,220. With regard to the disposal of the year's net income, they would observe that after paying 4 per cent interest on the £250,000 debenture stock and also the interest on the temporary loan sanctioned on March 28th, 1900—a loan which now amounted to £82,500 at 5 per cent.—a balance remained of £11,965, or nearly 5 per cent. upon the outstanding preference shares. Why, then, it might be asked, did they not recommend the payment of more than 3 per cent. on the preference shares? Those who had had experience of public companies would know the answer. It was the duty of the directors in a well-managed company to build up reserves, not only against depreciation, but for emergencies; and they must make it apparent also that their debenture interest was covered twice over, and was secured against all question. They had to get out of debt and establish their credit, and if they adopted the course recommended by the directors he thought they would soon accomplish those objects. He expected that out of the larger net revenue which was already in sight in the current year, they would be able to increase both their reserves and dividend on the preference shares, and then their debenture stock might be taken as an improved security. He dwelt upon that because they would issue £100,000 4 per cent. debenture stock at 94. The proceeds would pay off the temporary debt to the bankers and leave the company in a sound financial position. The price, of course, was cheap, but it was offered in the first instance to shareholders who could apply for as much as they liked, although, of course, it would be the duty of the directors to allot it *pro rata* to the holdings. Comparing the different figures of different years, the Chairman said that whereas in 1897 the number of units sold was 227,900, it would probably be 420,000 units or more for 1902. The cost in 1897 was 3·55d. per unit, but it would probably be less than 3d. for 1902. There were 123,000 odd lights in 1897, and would probably be 200,000 or more in 1902. The increase in the gross revenue was from £50,000 in 1897 to probably £82,000 or more in 1902, while the net revenue, which in 1897 was £16,570, would probably be £30,000 or more in 1902. Those figures, of course, were based on a variety of items such as the cost of coal, the increase of customers, the application of economical appliances, &c. There were four main directions in which improvement was possible in the company, viz.:—(1) The normal growth of the demand for the light, and that was coming at the rate of 1,500 lamps per month; (2) They had the largest undeveloped field in London of any electric lighting company, and judging from America, the demands of parishes like Bermondsey, Southwark, Chelsea and Rotherhithe, must be a continually increasing quantity; (3) They had at Deptford a station where electrical power could be generated probably a little cheaper than at any other station in London, and they were ready to sell power not only for lighting but for traction and motive purposes; and (4) There were the possibilities of the future with regard to utilising the lost units generated. There was a great difference in electric lighting companies between the number of units generated and the number of units sold. There was one company which had a compact rich area which brought to market 90 per cent. of units generated. Others, again, netted less than 70 per cent., and their company came between these extremes. But even now a loss of about 25 per cent. took place in distributing and transforming their current from the 10,000 volts at which it was despatched from Deptford to the 100 volts at which it was consumed. It was a technical problem upon which he did not propose to prophesy, but if it could be solved by inventive brains it meant the accession of profit which would compensate for extensive pioneering and for the legislative fetters which had bound the industry from the start in England and would give a fair return on capital.

Sir W. H. Preece, in seconding the motion, said that at the last meeting he took a rather optimistic view of their position, and was accused by some of being too sanguine. He need scarcely say that every hope he expressed had been fulfilled to the very letter. Sir William proceeded to explain a diagram on the wall which showed the variations of the load during selected days in winter and summer. He pointed out the lowness of the curve during the day time as compared with the night, and remarked that if they could get their current used in the day there was a potentiality of wealth. He believed that as time went on the demand of current for traction and manufacturing purposes would realise their most sanguine expectations.

After some discussion the report was adopted.

Notting Hill Electric Lighting Company.

Sir Wm. Crookes, F.R.S. (chairman) presided at the 15th ordinary general meeting of the proprietors of this company held on 18th inst., at the offices, 140, High Street, Notting Hill Gate, W.

In proposing the adoption of the report and statement of accounts for the year ending December 31st, 1901, the Chairman said that dealing with the accounts, he would go through them in the usual way seriatim, and give them information on points which might be considered important. Account No. 1 share capital, showed an increase, as it was found necessary to issue £22,000 ordinary share capital to meet necessary expenditure. Within the year they had received £9,136 of that amount, and the balance of £12,864, which became due on February 1st last, had been paid. That left an unissued balance of £56,000 to meet future capital expenditure, but the directors did not anticipate that it would be necessary to issue any further shares during the current year. Account No. 2 of loan capital had undergone no change, as although the authorised amount of debentures was 50 per cent. of the existing paid-up capital, nevertheless, without the sanction of a general meeting, the directors were unable to borrow more than the original amount of £50,000, and that, as they knew, had been previously issued in the form of 4 per cent. debentures. The total share and loan capital received up to the end of the year amounted together to £181,136. Capital account showed that the sum of £196,480 had been expended, which was £15,344 in excess of the capital receipts, but most of the balance had been provided out of the reserve fund, which was used in the business, and thus helped to increase the rate of dividend. The principal items of capital expenditure were £3,717 for lands and property, being part of the cost of the leasehold site for the Holland Mews distributing station, and the cost of the freehold of the workmen's cottages adjoining the works at the back of those offices, which were previously held on a short lease, and over which the company had Parliamentary powers of purchase, which would, however, have expired before the end of the year. The amount spent on buildings was £4,544, and was principally the cost of erecting the Lancaster Road and Holland Mews sub-stations, and the amount of £6,161 spent on new machinery represented a large proportion of the cost of equipping those distributing stations. There was no additional expenditure on accumulators, but the directors had under consideration the question of increasing the battery power in order to maintain the current at the steady pressure for which the company was noted. The largest item of expenditure was, as usual, upon new mains, and amounted to £15,258, which was principally the balance of the cost of the trunk mains from the joint generating station at Wood Lane to their company's sub-stations. Various other extensions of the mains had been made, in order to carry out the company's obligations, and to connect further customers, but the directors did not authorise any large expenditure in that direction, unless a good return was in sight. The cost of meters had increased by the sum of £1,104, but higher expenditure in that direction was always remunerative as it denoted increase in customers. The only other item in the capital account he need refer to was the cost of the Notting Hill Electric Lighting Act, 1901, £656. That sum represented the cost of obtaining an Act giving the company compulsory powers of purchase over a site in the Addison Road district for a distributing station. The expense and delay were necessary owing to the action of the freeholder of nearly all the property in that neighbourhood refusing his consent to the sale of any land to the company for the purpose of erecting a distributing station. The Act received the Royal Assent on July 26th, and arrangements were immediately made for the erection of the station in Holland Mews, but the delay in obtaining the Act proved fatal to their chance of utilising the plant for the winter's load, and unfortunately compelled them to refuse customers in that district. The station was now completed and ready to meet the demand for current, so that they were again in the fortunate position of being able to connect every installation. The revenue account No. 4 must, he thought, be considered very satisfactory, showing as it did a total profit of £13,046 against £9,856 for the previous year. The cost of coal still remained high, but the total shown in that account was about £1,000 less than last year. Rates and taxes had risen from £677 to £1,139, and were now becoming a very serious item. Although the revenue had increased over 20 per cent., from £19,900 to £24,100, the management expenses showed a slight reduction, from £3,019 to £2,975, and he mentioned the fact as he did not think it should be overlooked that the standing charges did not increase in anything like the proportion of the increase in the revenue, and, in fact, almost everything they received from new business beyond the works cost of producing the current, went to swell the total profit. The number of customers had increased from 1,191 to 1,445 during the year, and that rate of increase was more than maintained at the present time. The shareholders would doubtless like some explanation as to the reduction of dividend, notwithstanding the large increase in the profits. There were two or three reasons for the decrease, the principal being that the delay in obtaining the site for the Holland Mews distributing station prevented a large amount of additional capital, expended on mains and works, from being productive, although they had to pay dividend and interest on £79,500 more capital than last year. He was pleased to say that the distributing stations in Lancaster Road in the north, and Holland Mews in the south, were now completed, and would be in use as soon as the necessary junctions were completed, and they had at last got over the unsatisfactory position of having to refuse further customers. Negotiations were pending with the Kensington Borough Council for arc lighting in several of the principal streets in the company's area, and in order to meet the growing demand for current, two additional machines had been ordered to be ready for next winter's load. In conclusion, the chairman referred to the satisfactory way in which the Wood Lane works were being run, and remarked that they were now obtaining the principal part of their supply from that source, although they made full use of their old plant.

Mr. A. E. Franklin, J.P., seconded the motion, and the report, after a brief discussion, was adopted.

Winchester Electric Light and Power Company.

The directors' report, which was adopted at the meeting held at Winchester last Tuesday week, stated that the progress made during the year ending December 31st, 1901, was very satisfactory, 5,690 8-c.p. lamps having been added, making the total connection at the end of the year 20,815 lamps. Including the balance brought forward from last year's account, £125 19s., the account showed a net profit of £2,839 16s. which, after payment of debenture interest, left a balance of £1,839 16s. available for dividend. The directors recommended that a dividend be declared at the rate of 5 per cent. per annum, which will absorb £730 1s. 9d., and that £750 be placed to reserve for the renewal of plant, leaving a balance of £359 14s. 5d. to be carried to the next account. During the year large additions have been made both to the buildings and plant. The whole of the share capital has been issued and fully paid up. For the purpose of providing the further capital which will be required for extensions an extraordinary general meeting was called, to authorise the increase of the capital of the company by the issue of 5,000 new shares of £5 each, to be issued as the directors might from time to time determine.

Mr. T. F. Kirby, in moving the adoption of the report, said that this was the fourth of their annual meetings. At the first meeting they had scarcely begun business and they paid no dividend; at the second annual meeting they paid 2½ per cent., at the third 3 per cent., and at that meeting they were in a position to pay 5 per cent. Something like another 5 per cent. was placed to the reserve for the renewal of plant, and £359 was carried to the next account. That was a satisfactory state of things. They had been obliged to put in a fourth engine and boiler, and to add considerably to their plant, as well as to their cables and extensions.

Alderman Stopher seconded, and the report was approved.

At the extraordinary meeting, the resolution increasing the capital as mentioned in the report, was carried. The directors were authorised to issue the 5,000 new shares, either as ordinary or 5 per cent. preference shares as they might think expedient.

National Electric Wiring Company.

Mr. R. Stewart Bain (chairman) presided over the fifth ordinary general meeting of the above company on Tuesday at the Westminster Palace Hotel, and in moving the adoption of the report, said he could congratulate them on the successful year's work, and what to his mind was of even greater importance, the steady progress they had made as a company since they were incorporated. During the first year, 1898, they were organising a new business of a somewhat complicated and novel character, and they were quite contented when they made a profit of about £1,200, which they carried forward. In 1899 they entered on the dividend-earning stage, when, after making provision for depreciation, &c., they divided 3 per cent. In 1900 they advanced another stage, and divided 4 per cent., and this year, after nearly doubling the provision for depreciation, &c., they recommended a dividend of 5 per cent. He did not know how that rate of progress appeared to the shareholders, but to him it was more satisfactory than starting with large dividends, which gradually grew smaller; they were slowly and thoroughly building up a good business, and were now becoming known as, if not actually the largest wiring company in the kingdom, at any rate, one of the largest, and the contracts they were obtaining were growing in importance and magnitude. During the year they had carried out some very important work for the Government to their entire satisfaction. They hoped during the current year to make a commencement with naval work, and they had already secured a contract for the overhead equipment of tramways, so that the prospect was distinctly hopeful. During the year they completed 2,741 installations, with an aggregate of 78,943 lamps, this being an increase of 501 installations and 22,324 lamps. Of this total, 805 installations, with 25,000 lamps, were free wiring, and 1,936 installations with 54,700 lamps were contract, while they had orders in hand at the close of the year for 315 installations, with an aggregate of 29,342 lamps. During the three months of the present year additional orders had been received for 424 installations, with 13,436 lamps, and these figures pointed to a steady

increase in the company's business. The free wiring portion of the business showed a steady increase over that of last year, and what was of more importance to them, in nearly every case the revenue of nearly all free wiring contracts which were entered into was guaranteed by the lighting authority. During the year they entered into free wiring contracts with the Borough of Hackney and the Hornsey District Council, both of which they hoped would prove remunerative. With regard to the accounts, the gross profit for the year was £12,664 14s. 7d., as compared with £9,636 for the previous year, an increase of £3,028. Of this amount £3,666 was for free wire installations as compared with £2,120 for the previous year, an increase of 59 per cent. Their profit from contract work was £8,359 as compared with £6,864 for the previous year, an increase of 22 per cent. The other receipts for interest, discounts, &c., amounted to £938 as compared with £651 for the previous year, an increase of 42 per cent. With regard to the other side of the account, the total expenses were £9,060 as compared with £5,642 in the previous year; so that while the gross profit showed an increase of about 31½ per cent. their expenses showed only an increase of 7½ per cent. The allowances were £662 as compared with £573, and the balance left was £6,604 as compared with £3,993 for the previous year. From that they deducted provision for depreciation, &c., amounting to £2,522 as compared with £1,390 last year, which he hoped they would consider a wise provision on their part. It was the work of the board to place the company on a sound financial basis, and this could only be done by making ample provision out of profits for depreciation, and in doing so they were only fulfilling the pledge they gave in the prospectus. The balance which remained, viz., £4,081, was £1,479 greater than last year, which enabled them to declare a dividend of 5 per cent., and carry forward about the same sum as last year. Turning to the balance-sheet, they would see that the capital had increased from £75,000 to £87,000, and as the final call on the shares was made on Jan. 1st, they had received £3,504 in respect thereof. This made their subscribed capital paid up in full, and if the business continued to increase in the same ratio as heretofore, it might become necessary soon to consider the question of additional capital, and more especially if they were successful with some of the negotiations which they had now in hand for installations, running into considerable sums. The amount owing to creditors was £5,552, which was comparatively small, considering the amount of business they did. On the other side of the account it would be seen that the expenditure on free wired installations had increased from £33,178 last year to £42,685 this year. The amount expended on contracts in course of completion was £17,553, and showed an increase of nearly £7,000. Stock at head office and branches was £10,028, and also showed an increase, the increase in both cases being due to the large amount of work in hand. Furniture, fixtures, plant and tools, £1,651, showed a slight increase. Advertising and preliminary expenses had been reduced from £301 and £411 to £150 and £184 respectively, and they expected that during the current year these two items would disappear entirely from the balance-sheet. The sums owing to them, after making provision for doubtful debts, &c., was £16,572, being about the same as last year. This, considering the large amount of work they had done during the year, was very satisfactory, and for this and for the increases in their business they had to thank Mr. Cownie and his excellent staff.

Mr. W. R. Davies seconded the motion, and paid a tribute to the debt owed by the company to Mr. Cownie, the general manager, for his able management of the company's affairs.

The report was adopted.

County of London and Brush Provincial Electric Lighting Company.

Mr. J. Braithwaite, jun. (chairman), presided on Monday at Winchester House, E.C., over the annual meeting of the shareholders of the above company, and in moving the adoption of the report, said he thought they might congratulate themselves upon the extremely satisfactory progress which the company had made in every department. In the balance-sheet the chief item was the increase of capital expenditure during the year. The items amounted to £129,781 11s. 9d., and 31½ per cent. of that expenditure was on account of machinery and buildings, and the remaining 68½ per cent. on account of mains, transformers, meters, &c., which were rendered necessary by the development of the company's business as foreshadowed last year. In view of the very large areas over which the company had electric lighting rights, it was not probable that the capital account would be closed for some considerable time. He might take the opportunity of saying that probably the capital expenditure for the current year would not be so large, as they had provided machinery at their two lighting stations, which would serve their purposes for next year. The expenditure in the current year would be mainly for mains, and the balance of payment due to the generating machinery which had already been delivered. They had issued the remaining £100,000 debenture stock which completed that issue, and also a further £10,000 of their 6 per cent. cumulative preference shares. That would leave them with another £10,000 preference shares available for issue. Turning to the general revenue account, here they saw continuous progress in every item. The standing charges had increased from £11,148 last year to £12,668 13s. 11d. this year, and this was due to the increase in the company's business. On the other hand, their total receipts on the credit side had gone up from £38,516 to £56,613, so that while the increase on this side had been very large, the increase of expenditure had been very small; interest on dividends receivable was £4,754 against £3,896 last year, due to the improved prospects of their provincial companies. At Bournemouth the progress had been exceedingly satisfactory, and a dividend of 7 per cent. had been declared, as compared with 6 per cent. last year. At Dover the company had just declared a dividend of 5 per cent. on the ordinary shares, which was also an increase on last year; and in addition, the report just issued stated that the company had come to an agreement with the Corporation of Dover for the sale of the undertaking to the Corporation at a price which they said was calculated to work out at about £8 10s. for each £5 share. In looking at the balance-sheet, this point must be borne in mind—they had never written up their assets in provincial shares. Their Dover shares stood at par in the balance-sheet; so that if this agreement went through, and they received £8 10s. per share, it would represent a nice piece of legitimately-earned profit out of one of their provincial undertakings. The Bournemouth shares, which stood at from £12 10s. to £13, stood at cost price in their books, which was only a fraction over £10 per share; so that there was an undisclosed profit available for them at some time or another if they marketed their shares, or if the Corporation was prepared to pay the price for the business. With regard to Coatbridge, that had given a good deal of anxiety to the board in past years, but now their anxiety was greatly reduced. Arrangements had been made for putting down more economical generating plant, and powers had also been obtained for the lighting of Airdrie, and for laying down the Airdrie and Coatbridge Tramway. When the tramway was completed, they would supply it with current which would give them a large new day load. As regarded their provincial interests, they might say at Bournemouth, Dover, and Coatbridge they had every cause to be satisfied and gratified with the result of their capital embarked in these places. But as he had told them in previous years, the real backbone of the company were the London interests. To put the thing in a nutshell, the results of the past year's operations had been that on the north side of the river they earned £12,000 more at an increased outlay of £3,570. On the south side they had also, curiously enough, earned £12,000 more, but the increased cost had been £4,750, and this was partly due to the extra costs incurred in the dislocation of the station by the erection of new machinery, and partly due to the fact that on the south side of the river they had not the same power load they had in the north. He hoped, however, they would see a considerable improvement in that respect. The gross revenue from all sources during the year was £56,613, as against £38,516 for 1900, an increase of 47 per cent. for the year. But the net profit had increased 54 per cent., which showed that the previous outlay of capital in mains, &c., was gradually becoming remunerative. The increase on City Road station was 56 per cent., and on the Wandsworth station was 51 per cent. Everyone of the districts in which they carried on operations had shown an increased revenue and largely increased profits during the past year, and it showed that the additional units they manufactured and sold during the year were sold at a very small cost to the company. That was due very largely to the efforts of the chief engineer and station engineer in their close attention to details, and keeping down the costs consistent with efficiency. With regard to the net revenue account, they found some considerable changes. On the credit side of the account, whereas last year they brought in £33,860, this year they only brought in £16,938. They would remember that two years ago, when they disposed of the interest in their Richmond undertaking, they used the profit made on that to pay a small dividend on the ordinary shares, pending the time when the London stations would be built, and so last year nearly the whole of the dividend came from the profits of that sale. Last year they only earned £7,000 of the dividend, but this year they had earned the whole of it from their own stations without taking anything from extraneous profits. It was true they had not yet been able to provide out of revenue the sum they should place to the renewals fund, but no doubt next year they would be able to do so and maintain the dividend paid on the ordinary shares. After paying the dividend they carried forward rather a larger sum this year. A good deal was said about the price charged for electricity, but as a matter of fact their charges compared extremely favourably with those of other companies. They adopted the sliding scale, and the very small consumer was charged the maximum price of 7d. per unit. On the other hand, some of the largest consumers got their current for 3d. per unit. The average price received for the whole of the current supplied both north and south of the Thames was almost exactly 4½d. per unit, which gave no reasonable cause for complaint. The increase in their power load on the north side of the Thames was exceedingly encouraging and satisfactory, amounting to 127 per cent. Their motor power had almost doubled itself during the year, and they anticipated a still further increase as the advantages of electric motors became more known. With regard to lamps it would be satisfactory for them to know that the progress made by the company was relatively greater than any other company in London. During the past year they had 84,286 8-c.p. lamps additional, compared with 71,000 of the Metropolitan Company, 63,873 of the Westminster Company, 38,000 of the City of London Company, and 25,480 of the St. James's and Pall Mall Company. The increase was still going on, and since December 31st the increase was almost exactly the equivalent of 20,000 8-c.p. lamps, whilst the increase in profits this year so far appeared to have been about £2,500. They had one new area in which current was now available, from which they expected to obtain some marked results during the current year. The chairman proceeded to deal with the increasing tendency of municipalities and local bodies to harrass the British investor, and alluded to various forms of municipal trading. He said it was significant to notice that between 1875 and 1898—the period during which municipal trading had arisen so markedly—the rates in England and Wales had increased 87 per cent., and the outstanding debt charge had increased nearly 100

per cent. In the same period the increase of population was only 22 per cent., and assessable values only 28 per cent. Whenever a municipality saw anything which paid a profit, they wanted to take it over, but the beauty of the thing was that when they got a business which yielded a profit in the hands of the private company, they could not make it pay, which was not surprising seeing that the bodies were elected, and were constantly changing. Several municipalities had taken over the electric light undertaking, and their administration had yielded a loss to the ratepayers. Southwark, after five years' working, lost £7,489 last year; Glasgow, after eight years' working, lost £4,517 last year; Dublin lost £4,265; and Shoreditch £3,866, in spite of the efforts made to minimise the loss by transferring items to the dust destructor. That, however, was not the full loss to the ratepayers, for the rateable value they placed on their undertaking was nothing like that which was placed on the private companies. It had come to light that the Ealing Council had spent £109,000 on the undertaking, and assessed it at £755, and at Wimbledon, on the undertaking of which £57,700 was spent, the rateable value was put below £300. Then again in regard to street lighting, they offered to do the public lighting of Shoreditch at £27 per 2,000-c.p. nominal arc lamp, but the Shoreditch Council charged its ratepayers £42 per lamp for public lighting. Taking all the municipal undertakers, they charged their ratepayers 20 per cent. too much as compared with the companies. He urged the shareholders to protest against this increasing municipal trading. Another noticeable feature of late was the tendency of public bodies to depart from strict lines of honesty, and to do those things which, as individuals, the members would never do. They had had a flagrant instance in the case of the Corporation of the City of London, and the Camberwell Borough Council seemed evidently prepared to take a leaf out of their book. When their company got the consent of the local authority to go into Camberwell, they had to agree to sell at any time to the local authority at a fixed price. The local authority was to pay £133 for every £100 found to have been properly expended. The company had done a lot of pioneer work, and had only just begun to reap the fruits of their labour. Now the Borough Council wanted to take that over, but were looking round for some means of evading their obligations. They found in a small portion of their area a few mains laid by another electric lighting company, and they had bought these mains and were going to Parliament for power to supply the whole district on the strength of it. He hoped the efforts of the board to bring them to book would not be without success. Touching, in conclusion, on the depreciation fund, the chairman said he did not believe in a large depreciation fund, because if they had a big fund at the end of their term, those who wished to buy would point to the fund as evidence that they themselves considered it had depreciated by the amount of the fund. He believed in keeping their undertaking in good and proper condition, and having a depreciation fund sufficient for all contingencies.

Mr. F. W. Reynolds seconded the motion.

Considerable discussion followed, chiefly on the question of depreciation, it being urged that whilst the directors' policy in this direction had been justified as a policy of expediency, yet in the future more attention should be paid to the point.

The Chairman having reiterated his opinion on the question, the report was adopted.

Direct Spanish Telegraph Company.

The meeting of this company was held on Monday at the offices, Winchester House, Old Broad Street, the Marquis of Tweeddale presiding.

The Chairman, in proposing the adoption of the report, said the chief feature of the operations of the past year had been the very heavy expenditure entailed upon the company through the interruptions of their two cables, the Bilbao cable and the Barcelona—Marseilles cable. The Bilbao cable was interrupted for a period of a month, and cost them £4,074 to repair. The Barcelona—Marseilles cable was interrupted for the unprecedented length of time of three months, and its repair cost them £8,179. That was entirely due to the extraordinary bad weather which prevailed in that part of the Mediterranean during the early part of last year. Every possible effort was made by the repairing ships to repair the break quickly and promptly, but the bad weather defeated every effort of that kind. The third break occurred in the latter part of last year and lasted only 14 days, happily owing to the prompt manner in which the s.s. *Sir John Pender* was despatched from Gibraltar, where she was lying at the time. That break cost £2,976, making altogether the large sum of £15,230 spent on repairs during the year. Fortunately, they had in their possession a very handsome reserve fund, and they were enabled to meet that large expenditure without any difficulty whatever. The sum at the credit of the reserve or renewal fund was still £46,948. Those prolonged interruptions unfortunately prejudicially affected their traffic receipts, which were £699 less than last year. He was glad, however, to think that if it had not been for those long interruptions, their receipts would have been considerably in excess of the previous year, and therefore considerably above the average. The traffic on the Bilbao line was fairly well maintained; and as the traffic between Great Britain and Spain showed evident signs of increasing, they had every reason to hope that by this time next year the traffic returns on the Bilbao cable would show a distinct improvement. Their ordinary expenses at stations showed an increase of £526, which was almost entirely composed of two items—increase of salaries at the stations, amounting to £342, and increase of salaries at the head office of £61. Those increases were in accordance with a rule laid down by the directors, and they would continue until the maximum in each case was reached. The increases were only given to those officers who appeared to deserve them, but whenever that was the case the increase was given as a matter of course. The general expenses did not call for any particular comment, but he might, perhaps, refer to the reduction of £80 in the cost of automatic apparatus. They possessed now automatic apparatus of the very best quality and capable of doing any amount of work which it was at all likely it might have to carry through. Their experience of that automatic apparatus was entirely favourable both in respect to speed and accuracy. The net result of their operations was that they were able to recommend a dividend at the rate of 4 per cent. per annum, after placing £5,000 to the reserve fund and paying the usual 10 per cent. on the preference shares. In order to do that they had drawn £566 from the contingency fund and the small sum of £145 from the reserve.

Sir John Denison Pender seconded the motion, and the report was adopted.

City of Birmingham Tramways Company.

At the annual meeting held at Birmingham last week, Mr. James Ross, who presided, said that the results of the working of the Bristol Road line, in converting which to the overhead electric system the company spent a good deal of money, were turning out very satisfactory. That line was worked on the new system for 7½ months up to the end of December, and the net earnings were about £8,000, whereas, under the old storage battery system, it was hard work to meet expenses.

Mersey Railway Company.

The half-yearly report of this company contains the following paragraph:—"The directors regret the decrease in the traffic receipts, which is due to the opening of the Birkenhead electric tramway system, and which they believe will continue until the railway is worked by electricity. The contract with the British Westinghouse Electric and Manufacturing Company, Limited, provides for payment of the interest on the redeemable first, also the Mersey Railway new first perpetual debenture stocks until the railway throughout shall be available for public traffic worked by electrical power. The electrical works are in course of construction, and substantial progress has already been made."

Tynemouth and District Electric Traction Company.

The directors' report presented to the meeting at Donington House, W.C., states that the capital expenditure during the year 1901 amounted to £26,130 9s. 5d., the total capital outlay on the construction, re-construction, and electrical equipment of the lines being £78,434 9s. 9d. (including £5,089 19s. 5d. on the old line). The subscribed share capital is now £40,000 in ordinary shares of £5 each, and £30,000 in 5 per cent. cumulative preference shares of £5 each.

The total revenue from March 18th (the date of opening for traffic by electric traction) to December 31st amounts to £11,069 6s. 10d., and the expenditure to £5,700 16s. 9d., leaving a net profit of £5,368 10s. 1d., which, added to the amount of £55 6s. 11d. brought forward from last account, makes an available balance of £5,423 17s., which the directors recommend should be applied as follows:—

Amount to be placed to depreciation and reserve fund ..	£1,000 0 0
Dividend at the rate of 5 per cent. per annum on the cumulative preference shares for the year	900 0
Dividend at the rate of 7 per cent. on the ordinary shares for the year	2,800 0
To be carried forward to next account	723 17
	£5,423 17 0

The inquiry respecting the company's application for a Light Railway Order for the extension from the present terminus at Whitley to Whitley Sands, a distance of 4 furlongs 3 chains, was held on February 24th, 1902, and the Order (which was unopposed) has been passed by the Light Railway Commissioners, subject to confirmation by the Board of Trade. The lines, as constructed and equipped for electrical traction, were inspected by the Board of Trade Inspector on February 13th, 1901, and were opened for traffic on March 18th following. In order to provide for increased services, the directors have given instructions for the doubling of the track along the Grand Parade, Tynemouth, and the work will, it is hoped, be completed before the coming holiday season.

Miles Open:—	Year ended Dec. 31st, 1901.
Route miles	3·71
Single line	1·16
Double line	2·55
Number of passengers carried	1,723,218
Average receipts per passenger	1·51d.
Average expenditure per passenger	·78d.
Proportion of expenses to receipts	51 %
Number of cars in stock	22

Newmarket Electric Light Company.

The third annual meeting of the Newmarket Electric Light Company was held on Monday last week, Mr. G. H. Verrall, J.P. (chairman), presiding. The directors' report stated that satisfactory progress had been made during the past year, 2,611 8-c.p. lamps having been connected to the mains. Considerable additions had been made to the machinery and mains during the past year. The profit on the year's working, added to £205 15s. 2d. brought forward from last year's account, amounted to £1,138 0s. 11d., which, after providing for debenture interest, left a balance of £676 18s. 4d. The directors recommended the payment of a dividend of £2 10s.

per cent., that £100 be written off the preliminary expenses account, and that the balance £181 18s. 4d., be carried forward. The Chairman said they had now 11,107 8-c.p. lamps connected, and applications in hand for an additional 1,050. Applications equivalent to 2,086 8-c.p. lights had been received since the beginning of the year. Mr. A. H. Crowe was re-elected company's auditor; and the retiring directors, Messrs. G. H. Verrall and G. J. Jennings, were re-appointed.

Dover Electricity Supply Company.

The report to December, 1901, presented at the meeting held at Dover, on Wednesday, shows that a very material increase has taken place in the profits derived from the business during the year as compared with the previous 12 months. This is partly due to the increased output and partly to reduction in cost of coal, &c. A further substantial reduction on this account is also ensured during the current year from contracts already made. The board report the death in July last of Mr. C. W. Bagshawe, J.P., a director, who has been replaced by Mr. Henry Hobday.

During the year the equivalent of about 3,350 8-c.p. lamps have been added to the mains, besides several motors and numerous temporary lights. The additional lights represent a greater increase than in any previous year. The directors were able, a year ago, to report an increase of output for 1900, amounting to about 30 per cent., and they have now the pleasure to state that the increased private output for the past year over the combined private supply of 1900 is equal to 54 per cent., the number of units being as follows: 1899, 195,359; 1900, 261,154; 1901, 403,870. In order to further stimulate this increase, the directors some months since gave notice that the price of current would, under conditions of prompt payment, be reduced to 5d. per unit. Such reduction came into force as from January 1st last, and the directors have every reason to believe that the results to the company will be highly satisfactory. The capital expenditure during the year has been chiefly in the direction of main extensions, and a considerable sum could still be profitably employed in this direction. The directors have to report that negotiations for the sale of the company's undertaking to the Dover Corporation have led to their making a definite offer at the price of £142,228, which has been accepted subject to the consent of this company in general meeting, and to the necessary Parliamentary sanction being obtained. The price named will allow of a distribution of £8 10s. to each holder of a £5 share after payment of all the company's liabilities, and represent a fair return to those shareholders who have waited for the present prosperous condition of the company; and the directors recommend the shareholders to confirm the sale. The profits of the year amount to £4,729 17s. After payment of debenture and other interest there is an available balance of £3,507 4s. 10d., out of which the directors recommend the payment of a 5 per cent. dividend on the preference shares, absorbing £728 9s. 6d., and 5 per cent. on the ordinary shares, amounting to £2,500; the balance of £278 15s. 4d. being carried forward.

Ferranti, Limited.

The directors' report for the year ended December 31st, 1901 (the company, formed in July, 1901, having taken over the business from the beginning of that year) reads as follows:—

The gross profits (including dividends on British Insulated Wire Company shares, £4,299 15s.) amount to			£49,821 8 7
From this has to be deducted the total cost of administration, patent fees, and experimental expenses	£15,104 11 4		
Repairs and renewals	£3,756 1 1		
Depreciation	5,800 14 7		
		9,556 15 8	
			24,661 7 0
Leaving a net profit of			£25,160 1 7

The directors consider this result satisfactory. The plant and machinery has been kept in a high state of efficiency; £9,556, as shown above, has been charged against revenue for upkeep and depreciation.

Of the above balance .. .. is payable to the liquidator of the old company as interest on the purchase price, in accordance with the contract for sale.	£8,215 12 4	
Income-tax and directors' fees amount to	944 8 6	
Debenture interest and interest on loans	4,484 11 11	
Dividends on preference shares calculated from dates of payments of calls	1,091 9 0	
	14,686 1 9	
Leaving to be dealt with	10,473 19 10	
	£25,160 1 7	

In accordance with the articles of association, the sum of £2,500 will be applied to the reduction of patent's account, and it is proposed to write £1,100 off the formation expenses. In view of the amount of interest mentioned above, it is proposed to pay £1,784 7s. 8d. only, as dividend on ordinary shares. Of the balance of profit, *i.e.*, £5,089 12s., £3,000 will be transferred to reserve account, and £2,089 12s. 2d. carried forward. The directors hope to finally dispose, during the current year, of the "Expenditure on old engines," to meet which the sum of £14,000 was reserved at the formation of the new company. In view of the unexpected depreciation, since the issue of the prospectus, in the quoted value of British Insulated Wire Company's shares, which were taken over from the old company, Mr. Ferranti has executed an agreement undertaking to meet the deficit (if any) upon the sale of these shares, and has given security. They have, therefore, not been written down in the books. The orders in hand are over £60,000 greater in value than at this date last year. To meet the rapid increase in business, it has been found necessary to lease additional premises close to the existing works, which are being equipped as a switch works, the present accommodation for this branch of the business being quite inadequate. Amongst the orders recently obtained are important contracts for the London County Council, Manchester Corporation, and Capetown municipality. At the request of the chairman and directors, who hold amongst them all the ordinary share capital, Mr. Scott Lings has agreed to join the board.

British Columbia Electric Railway Company.

Mr. R. M. Horne-Payne, the chairman of this company, has made a report to the shareholders, giving the results of the visit he has made to British Columbia. The report was published at length in the financial press last week. He has inspected the whole of the company's property and plant, and calls attention to the great changes that have occurred in the district served by the company during the last few years. He recommends:—

(1) That the directors should be authorised to create £175,000 (part of £220,000) special 4½ per cent. 50-year debenture bonds, or to guarantee a similar amount of similar bonds of the Vancouver Power Company, in order to enable the Vancouver Power Company to construct and instal the Coquitlam water-power plant; (2) that power be granted to the directors to increase the capital by £300,000 from time to time, as occasion may require, for the general expansion of the business; (3) that the shares of the company be converted into stock; (4) that the present preference shares be converted into preferred (5 per cent. minimum) ordinary stock, and the present ordinary shares into deferred ordinary stock, and that £250,000 of the new capital be created as 5 per cent. perpetual cumulative preference stock and £50,000 as additional preferred (5 per cent. minimum) ordinary stock, and that provision shall be made in the articles providing that there shall at no one time be outstanding more preference than there is of preferred ordinary stock, and also of deferred ordinary stock already outstanding, and that at no one time shall there be more preferred ordinary stock outstanding than there is already of deferred ordinary stock outstanding. The effect of this is that there will be £250,000 in each of the three issues of capital and £250,000 of debentures, and that ample provision will be made for the growth of the company.

Potteries Electric Traction Company.

The directors' report for the year ended December 31st, 1901, reads as follows:—

The gross receipts for the year amount to £86,386 4s. 1d. After deducting all expenses chargeable to revenue, including repairs and maintenance and interest on loans and debentures, there remains a net profit of £19,650 14s. 6d. To this has to be added £205 15s. 9d. brought forward from the previous account, making an available balance of £19,856 10s. 3d. which the directors recommend should be applied as follows, viz.:—

To provide for dividend for the year on the cumulative preference shares	£10,054 3 4	
To pay a dividend on the ordinary shares of the company at the rate of 4 per cent. for the year	8,048 16 9	
To transfer to the credit of depreciation and reserve fund	1,500 0 0	
To carry forward to next account	253 10 2	
	£19,856 10 3	

During the year traffic receipts have increased and administration and other expenses have been reduced, but the company's business has suffered considerably from the general stagnation in the trade of the district, and loss has been sustained through the reduction of the service between Hanley and Longton, pending the reconstruction of part of the old line in Fenton of the North Staffordshire Tramways Company.

In April last the British Electric Traction Company, Limited, exercised the option to subscribe for £75,000 debenture stock referred to in the last report. The directors have considered it desirable for the company to acquire the outstanding £20,000 5 per cent. debentures of the North Staffordshire Tramways Company, and in order to carry this into effect 3,000 ordinary and 2,000 5 per cent. preference shares of £10 each were issued to the shareholders on which £1 per share has been called up. This has enabled the directors to offer £20,000 4½ per cent. debenture stock to the holders of the 5 per cent. debentures of the North Staffordshire Company in payment for their debentures, and this company now holds all the issued debentures of the North Staffordshire Company except £150. The total capital expenditure to December 31st, 1901, was £415,496 17s. 3d. in addition to £205,333 10s., the cost of the debentures and shares held by the company in the North Staffordshire Tramways Company, Limited. The light railway order applied for in 1900 has now been granted. The directors propose to commence the construction of some of these lines forthwith. In order to cope with the increased demand for services, additional plant has been installed, and the system of electrical feeders has been extended. The rolling stock has been augmented, and the company has now a total of 105 cars. The express parcels delivery service was commenced towards the end of the year, and has dealt successfully with a large amount of business. Receiving offices have been opened in Stoke, Hanley, Burslem, Newcastle, Longton, &c., and agents have been appointed throughout the district. The directors have appointed Crouch's Universal Parcels Express Company for business in London and the provinces, in connection with this service. Some capital expenditure has been necessary for the purchase of vans and other apparatus.

The directors have received applications from various local authorities for extensions of the system into parts of the district not yet served by the tramways, and these suggestions are receiving the careful consideration of the directors. The negotiations with some of the local authorities for the transfer to the company of their electric lighting orders have been postponed. The directors have considered it desirable to join with the North Staffordshire Tramways Company in applying to Parliament in the present session for a Bill to confirm certain agreements with the local authorities, for power to appoint an arbitrator in certain eventualities, and for other purposes. The Bill has passed second reading. During the year Mr. J. S. Raworth has retired, owing to other engagements, and the directors have elected Mr. George F. M. Cornwallis-West to fill the vacancy thus caused on the board. The directors retiring this year are Mr. Stephen Sellon, Mr. Stephen Mear, and Mr. George Cornwallis-West, who are eligible for re-election. Messrs. Bourner, Bullock & Co., the auditors, also retire, and offer themselves for re-election.

	1900.	1901.
Miles Open—	m. f. c.	
Route miles	23 0 1	28·95
Single line	17 6 0	22·95
Double line	5 2 1	6·0
Number of passengers carried	9,841,466	13,361,778
Average traffic receipts per passenger	1·32d.	1·32d.
Average expenditure per passenger ..	0·83d.	0·88d.
Proportion of expenses to receipts ..	62%	67%
Number of cars in stock	78	105

Oxford Electric Company.

Sir Henry Mance presided at the annual meeting held at Oxford last Friday week, and in moving the adoption of the report, which has already appeared in our columns, he detailed the various extensions to plant and mains which had been carried out during the year. 803,000 units were generated against 657,000 in 1900—an increase of 22 per cent. The units delivered were 570,000 as against 484,000 in 1900. 1,727 tons of coal were consumed against 1,337 in the previous year. The cost of coal per unit had slightly increased

Prospectus.—The list was to close yesterday (Thursday) for an issue of 28,503 ordinary £10 shares in the Auckland Electric Tramways Company, Limited. The shares were offered by the Electric and General Investment Company, and the issue was guaranteed by the British Electric Traction Company. The company has taken over the lines of the New Zealand Electric Light and Traction Company, Limited, which, with certain extensions (for which powers have been obtained by local authorities and delegated to the company), makes a total route length of 18 miles. The nominal capital is £300,000. The contracts for the conversion to electrical traction, and the equipment of the extension lines, are being carried out by Messrs. J. G. White & Co., Ltd.

Direct United States Cable Company.—Interim dividend 3s. per share (at the rate of 3 per cent. per annum), for the quarter ending March 31st, 1902.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending March 21st were £655; corresponding week last year, £551; increase, £104. Total to date, £6,861; corresponding period last year, £6,188; increase £673. Miles of track open, 10½.

Blackpool and Fleetwood Tramways.—The receipts for the week ending March 22nd were £212; corresponding week last year, £162; increase, £50. Total receipts to date, £1,936; corresponding period last year, £1,736; increase, £200.

Bristol Tramways and Carriage Company.—The receipts for the week ending March 21st were £4,094; corresponding period last year £3,576; increase, £518.

British Electric Traction Company.—The following returns are issued of the undertakings of this company for the week ending March 14th:—

Company.	Amount £	Comparison with corresponding week of last year. + £	− £	No. of weeks.	Aggregate. Amount. £	Inc. or Dec. + £	− £
Devonport ‡	437	—	—	10½	4,005	—	—
Dudley—Stourbridge	663	143	—	10½	6,286	1,146	—
Gateshead ‡	633	—	—	10½	6,400	—	—
Greenock-Pt. Glasgow	867	200	—	10½	8,683	1,939	—
Hartlepool	176	—	9	10½	1,723	—	31
Kidderminster ..	97	10	—	10½	916	80	—
Merthyr	205	—	—	10½	1,929	—	—
Oldham—Ashton ..	171	7	—	10½	4,635	—	53
Poole†	198	—	—	10½	1,824	—	—
Potteries	1,416	95	—	10½	13,828	365	—
Southport	144	24	—	10½	1,270	193	—
South Staffordshire†	778	76	—	10½	7,229	331	—
Swansea	408	46	—	10½	4,044	826	—
Taunton ‡	54	—	—	10½	528	—	—
Tynemouth ‡	178	—	—	10½	1,840	—	—
Wolverhampton Dist.	140	92	—	10½	1,241	779	—

† Partly steam. ‡ Not in operation last year

Central London Railway.—The receipts for the week ending March 22nd were £6,824; corresponding week last year, £6,188; increase, £636. Total receipts to date, £79,719; corresponding period last year, £73,007; increase, £6,712. Miles open, 6.

City and South London Railway.—The receipts for the week ending Mar. 23rd were £2,813; corresponding week last year, £2,089; increase, £724. Total receipts to date (12 weeks), £36,285; corresponding period last year, £24,315; increase, £11,970. Miles open, 6½; last year, 4½.

Dover Corporation Tramways.—The receipts for the week ending March 22nd were £169 12s. 2½d.; corresponding week last year, £154 18s. 1d.; increase, £14 14s. 1½d. Total to date, £1,951 16s. 4½d.; corresponding period last year, £1,844 17s. 9½d.; increase, £106 18s. 7d. Miles of track open, 8. Car miles run, 1902, 5,120; 1901, 4,991. Number of cars, 1902, 12; 1901, 11.

Dublin United Tramways Company.—The receipts for the week ending March 21st were as follows:—D.U.T. Co., £3,486 17s. 2d.; D.S.D. Co. £724 16s. 8d.; total, £4,211 13s. 10d.; corresponding week last year—D.U.T. Co., £3,076 7s. 1d.; D.S.D. Co., £645 13s. 6d.; total, £3,722 0s. 7d.; increase, £489 13s. 3d.; aggregate to date, £45,735 0s. 0d.; last year, £43,374 7s. 3d.; increase, £2,360 12s. 9d. Mileage worked 46.

Liverpool Overhead Railway.—The receipts for the week ending March 23rd were £1,392; corresponding week last year, £1,475; decrease, £83. Total to date £16,451; corresponding period last year, £17,744; decrease, £1,293. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Tuesday Evening.

Despite the approach of the holidays, business in electrical descriptions is fairly brisk. British Electric Tractions are coming to the fore. Supply shares, although they fail to recover some of the recent losses, are commanding a very free market, and the telegraph department is being timidly approached by a few buyers. The Electric Railway section is noticeable only from the continued dulness of Central London issues. City and South London is hardly mentioned, but its pre-Ordinary descriptions show a tendency to slide off in sympathy with the rest of that gilt-edged group. A large emission of new London and North-Western Preference stock has proved abortive, and consequently all like securities are tapering off in price.

In some direction a good deal is being made of the prospects of the electric lighting companies in view of the Coronation. It is argued that the supply undertakings must mint money during the festivities, and that a purchase of Westminster, St. James's, Charing Cross and City of London shares will probably show a large and early profit. But on the other hand, it may be pointed out that while more current will be used in the streets, there may be a decrease in that consumed indoors, since the illuminations will look well only if the surrounding area forms a dark background. Therefore, while admitting the prospects and hoping for a capital season, we are somewhat sceptical as to the likelihood of any pronounced rise such as some of our contemporaries appear to contemplate. Were the depreciation accounts of certain electrical supply companies in better condition, the prudent investor would be more drawn to the market; our strictures upon this point are likely to be emphasised in the near future by some of the weightiest authorities in the world of financial journalism. The severe decline in Brush shares is partially due to fears of what the report may have to say on this very subject, nervous apprehensions being conjured up. The company's statement is due after Easter, and it is awaited with lively interest.

Telegraph stocks are attracting attention from investors tempted by the shake-out to have a flutter in this market. The Marconi scare is again passing away, and with it the altitude attained by Marconi shares. The latter are now sellers at 3¼, notwithstanding the buoyancy of their foster-brothers, South African Gold Mining shares, the two classes being dealt in side by side. It is difficult to realise how sharp the relapse has been in telegraph securities until the figures are shown at a glance. Taking the *lowest* quotations of a few representative stocks and shares in the last four years, we have this record:—

Stock or share.	1898.	1899.	1900.	1901.	Now.
Anglo-American Preference	107	110	95	86½	90
Direct United States.. ..	11¼	12 3/16	10	7⅝	10
Eastern	167½	140⅝	136	131⅛	130
Eastern Extension	17¼	13⅜	13⅜	12⅜	13
Great Northern	26	28¼	30½	29	28

With regard to Eastern Ordinary in 1898, the shares were not converted into stocks at that date, but for purposes of comparison we have treated the price as though the conversion had gone through.

Our table shows the lowest prices since 1897, and without going into such detail with regard to the highest, it is sufficient to point to three or four quotations which have been attained within the same period. In 1899, Anglo "B" ran up to 121, and even last year it stood as high as 102 at one time. Eastern Ordinary has fallen from 183, its highest price in 1899, although the £10 shares reached 18½ in '96. Last year the maximum was 151, and the present price is rather over 130. Eastern Extension shares, now about 13, were 19¼ four years ago, and 14⅜ at one time in 1901. Yet both the Eastern and the Eastern Extension Companies have paid 7 per cent. regularly every year since the last Jubilee in 1897, and the Great Northern dividend of 30s. per share for 1901 was the best paid for five years. It is observable by these illustrations that the Telegraph market is not being exploited unjustifiably by those in search of good speculative investments at low prices.

One or two new issues claim attention, that of the Auckland Electric Tramways being the most ambitious. The prospectus shows the company to be allied with the British Electric Traction Company, and under the auspices of that concern the shares may possibly be led to a gentle premium. The shares are, of course, an investment of very highly speculative type. Soon after Easter we are to have the launching of a big company for the supply of electric power in South Wales. Ferranti, Limited, whose prospectus was issued only a year ago, shows profits for its first 12 months' work of £25,160 net, an eminently satisfactory result. The directors, however, are only distributing £1,784 to the Ordinary shareholders, very generous appropriations being made to reserve, patent account, depreciation, and other similar funds.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations March 19th.	Closing Quotation March 25th.	Business done during week ended March 25th, 1902. Highest.	Lowest.
82,300	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	...	...	...	3½— 4½	3½— 4½	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	70 — 80	70 — 80	...	...
804,720	Anglo-American Telegraph	Stock	73/6	3½%	61s.	46 — 49	46 — 49	49	...
3,097,640	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	89 — 91	89 — 91	91	90
3,097,640	Do. do. Deferred	Stock	£1 7s.	5s.	2s.	7¼— 7¾	7¼— 7¾	7 7/16	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	...	3½— 4	3½— 4	...	...
13,333,300$	Commercial Cable	$100	8 %	...	...	155 —165	155 —165	...	...
1,741,029£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	95 — 97	95 — 97	96¼	95
16,000	Cuba Telegraph	10	7 %	...	...	4½— 5½	4½— 5½	...	...
6,000	Do. 10 % Pref.	10	...	...	...	13 — 14	13 — 14	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	8½— 9½	8½— 9½	...	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	98 —102	98 —102	...	...
60,710£	Direct United States Cable	20	3½%	3¼%	...	9½— 10½	9½— 10½	...	...
101,300£	Direct West India Cable, 4½ % Reg. Deb., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	125 —135	125 —135	131	128
1,930,807	Do. 3½ % Pref. Stock	100	...	...	...	85 — 88	85 — 88	86½	85
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	105 —109	105 —109	107½	105
300,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	12½— 13½	12½— 13½	13¼	13 1/16
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	108 —113	108 —113	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	5¼%	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—3,000	25	...	...	...	100 —103	100 —103 %	...	...
180,227	Globe Telegraph and Trust	10	5¼%	5¼%	...	8½— 9½	8½— 9½	9¼	9
180,042	Do. do. 6 % Pref.	10	...	...	...	13 — 14	12½— 13½	13 1/16	13
150,000	Great Northern Telegraph, of Copenhagen	10	...	15 %	...	27 — 29	27 — 29	27⅞	...
75,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —103	99 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	37 — 41	35 — 39	35	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	100 —104	100 —104	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	2½%	...	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	...	...	⅝— 1	⅝— 1	...	...
983,333	National Telephone, Pref. Stock	100	5 %	5 %	5 %	95 — 99 xd	95 — 99	98¼	96
200,000	Do Pref. shares	2	...	3⅛	3⅜	... — ...	3½— 3⅝	...	...
1,066,667	Do Def. Stock	100	...	60	61 xd	... — ...	60 — 64	61	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15 xd	13 — 15	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15 xd	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅞— 5½xd	4⅞— 5⅛	4 15/16	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	93 — 96	93 — 96	...	...
500,000£	Do. 4 % Deb. Stock Red.	100	...	4 %	4 %	101 —105	101 —105	101¼	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	6 %	...	⅞— 1	⅞— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	6½— 7½	6½— 7½	...	...
3,303	Submarine Cables Trust	Cert.	...	...	...	119 —125	119 —125	...	...
58,000	United River Plate Telephone	5	7 %	...	...	4⅜— 5¼	4⅜— 5¼	...	...
40,008	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4½— 5	4½— 5	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	102 —105	...	...
155,600	West African Telegraph, 5 % Debs....	100	...	...	...	99 —101	99 —101	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	⅛— ⅜	⅛— ⅜	...	...
150,000£	Do. do. 4 % Deks., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	12 — 13	12 — 13	12⅜	12¼
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	102 —105	102 —105	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	99 —102	99 —102	...	...
88,321	West India and Panama Telegraph	10	⅝%	...	...	⅛— ⅜	⅛— ⅜	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	5 — 5½	5 — 5½	5	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	3½— 4½	3½— 4½	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

100,000	Blackheath and Greenwich Dist. Electric Light, Ord. ...	1	...	...	...	⅜— ⅝	⅜— ⅝	...	...
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	...	...	...	100 — 105	100 —105	...	...
19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	8 %	8⅜— 9¼xd	8⅜— 9¼	8⅝	...
20,000	Do. do. 7 % Cum. Pref....	5	...	...	..	8⅜— 9¼xd	8⅜— 9¼	...	...
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	9 — 10	9 — 10	9 7/16	9¼
50,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅝	5¼— 5⅝	5⅝	...
250,000	Do. do. do. 4% Deb. Stock Red.	100	...	...	...	104 —106	104 —106	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	5½%	4 %	5 — 5½xd	5 — 5½	5 7/16	...
150,000£	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	110 —113	110 —113	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	4 %	0 %	5 %	8 — 9 xd	8 — 9	8⅜	8½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13 xd	12 — 13	12⅜	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	123 —128	123 —128	...	...
200,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	...	...	...	101 —104	101 —104	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	4 %	4 %	4 %	8½— 9½	8½— 9½	9⅛	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	12 — 13	12 — 13	..	...
400,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	..	107 —110	107 —110	109	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	7 %	...	6 — 6½	6 — 6½	...	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	6 — 6½	6 — 6½	6¼	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	106 —109	106 —109	108½	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	11%	12%	10%	10½— 11¼xd	10 — 11	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	...	...	4 — 5	4 — 5	...	...
250,000£	Do. do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	95 —100	95 —100	...	...
98,769	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	6½%	15½— 16½	14½— 15½	15 3/16	15
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	111 —115	111 —115	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	98 —101	98 —101	...	...
8,652	Notting Hill Electric Lighting	10	7 %	7 %	6 %	14½— 15½	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8 — 9	..	...
150,000£	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	1⅜— 2¼	1⅜— 2¼	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
109,518	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	11 — 12	11 — 12	11⅜	11

* Subject to Founders Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
§ Dividends paid in deferred share warrants, profits being used as capital.
£Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation Mar. 19th.	Closing Quotation Mar. 25th.	Business done week ended Mar. 25th, 1902. Highest	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	4½ — 5½	4½ — 5½	...	...
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	88 — 92	88 — 92	...	...
62,074	British Electric Traction	10	8 %	9 %	...	13 — 14	13 — 14	13⅞	13⅝
90,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12¼ — 12⅝	12¼ — 12⅝	12⅝	12 7/16
600,000£	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —129	...	...
70,000	British Insulated Wire Ord.	5	20 %	15 %	...	9½ — 10½	9½ — 10½	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝ — 6¼	5⅝ — 6¼	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	8 %	...	14s. to 16s.	18s. to 20s.	...	...
50,000	¶ " " " 6 % Cum. Pref.	£1	...	6 %	...	16s. to 18s.	19/6 to 20/6	...	...
105,731	Brush Elecl. Engng., Ord., 1 to 105,731	2	5½%	5 %	...	1⅜ — 1⅝	½ — 1	1 1/16	1⅛
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	...	2 — 2¼	1 — 1½	1⅝	1¼
125,000£	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	101 —104 xd	101 —104	101¾	...
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	97 —100	97 —100	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	17½ — 18½	17 — 18	17	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½ — 6	5½ — 6	5 1/16	5⅛
90,000£	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	111 —115	111 —115	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	4 %	99 —102	99 —102	101	98
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	4 %	103 —106	103 —106	...	...
440,100	Do. do. Def. do.	Stock	...	...	4 %	98 —101	97 —100	97	...
855,000	City and South London Railway	Stock	1½%	1½%	2 %	65 — 68	65 — 68	67½	66
54,000	Crompton & Co., Nos. 1 to 54,000	3	7½%	8 %	...	3 — 3½	3 — 3½	...	...
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —104	99 —104	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	2½%	...	⅛ — ⅜	⅛ — ⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	2½%	...	2 — 3	2 — 3	...	...
344,023£	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	78 — 83	78 — 83	...	...
100,000£	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	83 — 88	83 — 88	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅝ — 1⅞	1⅝ — 1⅞	...	...
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390... ...	2	...	...	...	2½ — 3	2½ — 3	...	...
182,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	97 —101	97 —101	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9¾ — 10½	9¾ — 10½	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	100 — 103	100 —103	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	17½ — 18½	17½ — 18½	17⅝	17
35,000	Do. do. do. 4½ % Pref.	5	4½%	4½%	...	5½ — 6	5½ — 6	...	...
50,000£	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	...	...
300,000£	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	100 —103	99 —102	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¾%	3¼%	1½%	5 — 5½	5 — 5½	...	...
10,000	† Do. do. Pref., £10 paid	10	5	...	...	11 — 11½	11 — 11½	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500	10	...	...	...	15½—16½	15½—16½	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	6 %	...	19/- to 20/-	... — ...	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	17½%	20 %	35 — 38	35 — 38	...	...
150,000£	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	102 —105	102 —105	...	...
25,000	Telegraph Manufacturing, Ord. Nos. 1 to 25,000	5	12 %	12 %	...	10½ — 11½	10½ — 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000£	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	92 — 95	92 — 95	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 1/10—3/16.
National Electric Free Wiring, 1/16—1/8.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14½—15
Do. do. Pref. (£10 pd.), 10⅜—10⅝

* From Birmingham Share List. ¶ From Manchester Share List.

Bank rate of discount 3 per cent (February 6th, 1902).

MARKET QUOTATIONS, Tuesday, March 25th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	22/-	22/-	..
a " Oxalic	per cwt.	32/-	32/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	89/-	89/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a " " ..	per ton	£90	£90	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a " (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£20	£20	..
a Lead, Nitrate	per ton	£24	£24	..
a " White Sugar	per ton	£31	£31	..
a " Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8d.	8d.	..
a " Caustic (76/80%) ..	per ton	£24	£24	..
a " Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	117/-	117/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	£6 5	..
a " Recovered	per ton	£5 10	£5 10	..
a " Lump	per ton	£6	£6	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a " Crystals	per ton	£3	£3	..
a " Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b " Wire, in ton lots	per ton	£224	£224	..
b " Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £125	£75 to £125	..
c Brass (rolled metal 9" to 12") basis	per lb.	6⅞d.	6⅞d.	..
c " Tube (brazed)	per lb.	8¼d.	8¼d.	..
c " " (solid drawn) ..	per lb.	7d.	7d.	..
c " Wire, basis	per lb.	7d.	7d.	..
c Copper Tubes (brazed)	per lb.	8¾d.	8¾d.	..
c " " (solid drawn) ..	per lb.	9d.	9d.	..
g Copper Bars (best selected) ..	per ton	£71	£71	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£71	£71	..
g " Rod	per ton	£71	£71	..
e " Electrolytic) Bars ..	per ton	£63	£69	..
e " " Sheets ..	per ton	£75	£75	..
e " " Rod ..	per ton	£68	£68	..
e " " H.C. Wire	per lb.	8d.	8d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f " Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/1½ to 3/3	3/1½ to 3/2	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i " Pig (Cleveland warrants) ..	per ton	46/9½	46/4½	5d. inc.
i " Forgings, according to size	per ton	From £11	From £11	..
i " Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i " Wire, galvanised No. 8 ..	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11 7 6 to £11 8 9	£11 12 6 to £11 15	5s. to 6/3 dc.
g " " Sheet	per ton	..	£13 10	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d " " " medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	11½d. to 1/3	11½d. to 1/3	..
p " rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p " " strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	10d. to 1/-	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i " " in bars		£68	£68	..
g Tin, block	per ton	£118 to £119	£117 10 to £118 10	10s. inc.
g " foil	per lb.	1/6	1/6	..
m " wire, Nos. 1 to 16	per lb.	1/6	1/6	..
p White Anti-friction Metals —				
"White Ans" brand	per ton	£35 to £65	£35 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j " 6 ten. Flax	per lb.	6¾d.	6¾d.	..
j " 3 ply 10 lbs. Russian ..	per lb.	4 1/2d.	4½d.	..
j " 10 lbs. Russian, single ..	per lb.	4½.	4½d.	..
j " 180 lbs. June rove	per ton	£10 2 6	£10 2 6	..
k Zinc, Sheet (Vieille Montagne brd.)	per ton	£22 10	£22 10	..

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd c Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works g Messrs. James & Shakespeare. (Co., Ltd. h Messrs. Edward Till & Co. i Messrs. Bolling & Lowe. j Messrs. Walter H. Hindley & Co.

Quotations supplied by { k Messrs. Morris Ashby, Limited. m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS. (MANCHESTER SECTION).

ELECTRIC FURNACES.

By Bertram Blount.

(*Paper read March 4th*, 1902.)

The function of an electric furnace is to produce a temperature of a degree, or in a place, unattainable by other means.

The first proposition is proved by the fact that such substances as silicon carbide or carbon boride cannot be prepared by any other method than the use of the electric furnace, because they need for their formation a temperature higher than 2,000° C.; the second is illustrated by the incandescence of the filament of a common glow lamp, inaccessible to ordinary methods of heating. The rough limit of temperature set (2,000° C.) depends on the point of dissociation of all compounds of carbon and hydrogen with oxygen.

We have no evidence that quartz is volatile at any temperature reached in industrial non-electrical furnaces, and these at their best give a temperature not greatly above the fusing point of platinum (1,775° C. = 3,227° F.). We may conclude with fair approximation to accuracy that the highest temperature attainable from fuel is at or about 2,000° C.

But by the use of electrical energy the whole output of a large prime mover can be expended in a small box so well isolated that its loss of heat is insignificant. The natural and inevitable result is the production of an exceedingly high temperature. The advantages thus gained have been turned to excellent account industrially and in chemical research.

No dissertation on the subject of electrical furnaces would be in any sense adequate without due reference to the work of Moissan. This bold and original chemist has done more to put our knowledge of reactions at high temperatures on a sound footing than any of his predecessors or contemporaries. Moissan has succeeded in fusing, volatilising and crystallising such refractory materials as lime, magnesia, platinum, silica, zirconia and carbon. He has studied the allotropy of carbon, and incidentally produced the diamond; he has prepared a whole series of novel carbides, borides and silicides, and on the basis of his experiments he has advanced a new and sagacious theory of the origin of petroleum.

Looking through Moissan's work, I have picked out those substances and reactions which seem to me most likely to become of industrial importance.

Calcium carbide and silicon carbide (carborundum) are already commercial products.

Alumina is one of those oxides which fuse and volatilise in the electric furnace; on cooling it crystallises as corundum, or, if a trace of chromium is present, as ruby. The case of carbon and its conversion to the octahedral form (the diamond) is too trite for repetition, but the inventor who succeeds in preparing masses of this very hard substance in a determined shape, and not brittle like the natural crystals, is certain of reward.

A substance which may sooner be made in quantity and put into use is fused silica. Prof. Boys first demonstrated the great possibilities of this material. Mr. Shenstone has shown that quartz fused before the oxyhydrogen blowpipe is in all ways superior to glass as a transparent and refractory material for the construction of apparatus. At present tanks of glass of fair size can be cast in spite of the brittleness due to its internal tensions. With quartz fused by the ton, and similarly cast, it should be possible to prepare great vessels indifferent to sudden changes of temperature and practically permanent under the most severe conditions. Investigations in this direction are being prosecuted by Mr. R. S. Hutton, who has achieved some remarkable results.*

Proceeding with our catalogue of useful substances, graphite may be mentioned. Natural graphite is a gritty and inferior material. A hard cutting siliceous ash will make graphite useless as a lubricant, and the merit of some of the brands esteemed for this purpose no doubt rests on their mineral contents chancing to be soft or even lubricative. But with artificial graphite this good property could be procured by design instead of accident. All forms of carbon, crystalline or amorphous, are converted into graphite at a temperature sufficiently high. It follows that artificial graphite may be manufactured by heating directly any kind of carbon sensibly free from mineral matter. A method, differing from this in principle, consists in dissolving carbon in a fused metal until it is saturated at a high temperature; on cooling, a portion of the carbon is thrown out of solution as graphite.

Crystallisation from a supersaturated solution of carbon in a metal, or its carbide, may be supplemented by providing the metal with some other substance with which to unite, and thus displacing the carbon. All engineers know that grey pig run down in a cupola becomes harder, but not everyone may be aware that this is due to selective oxidation which tends to eliminate silicon, and thus to allow the recombination of the iron with carbon previously displaced by that silicon as graphite. Conversely if silicon is added to iron saturated with carbon a portion of the carbon will be displaced and appear as graphite. There are, therefore, three methods for the manufacture of graphite by means of the electric furnace.

Acheson in his U.S.A. Patent No. 568,323 claims broadly the manufacture of graphite by the decomposition of a carbide, a claim which clearly is untenable because the decomposition of a carbide and the production of graphite thereby have been known for many years. Whether Acheson's methods are followed or not, it is probable enough that artificial graphite will eventually displace the natural material. Graphitised carbons are also manufactured by heating ordinary carbons electrically to a temperature high enough to convert them partially into graphite.

A number of refractory metals, such as chromium, tungsten and molybdenum, can be readily prepared in the electric furnace; some at least—*e.g.*, chromium—can be prepared more rapidly and in

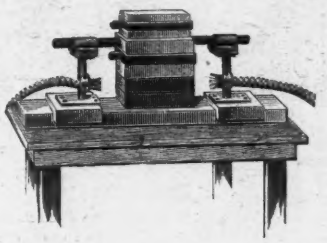


Fig. 1.

greater purity by a purely chemical method, viz., by the reduction of their oxides by aluminium. But although the electric furnace is thus put momentarily in the background, an electrical method is still a necessity, for the only process for making aluminium which is at present feasible is electrolytic. When it is generally realised that aluminium may be regarded as a powerful, compact and non-volatile fuel, that metal will be manufactured, perhaps somewhat impure, but cheaply and in quantity for a variety of purposes quite distinct from those which it serves as a metal useful in the arts.

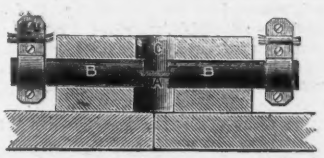


Fig. 2.

The last substance which I shall mention is carbon boride, CB_6. The chief industrial merit of this substance is its extreme hardness, which approaches that of the diamond.

Types of Electric Furnaces.

There are two types of electric furnace, the arc and the resistance furnace. Both are used in industry. The simplest effective form of arc furnace is that devised by Moissan, shown in the accompanying figure (fig. 1). It consists of two blocks of chalk carefully dried and carved out so as to form a cavity in which a carbon crucible can be placed. Massive carbon electrodes pass into this cavity, and the arc formed between them plays over the hearth, heating the material to be treated in the manner of a common reverberatory furnace. The chief merits of the furnace are its extreme simplicity and the refractoriness and low conductivity of

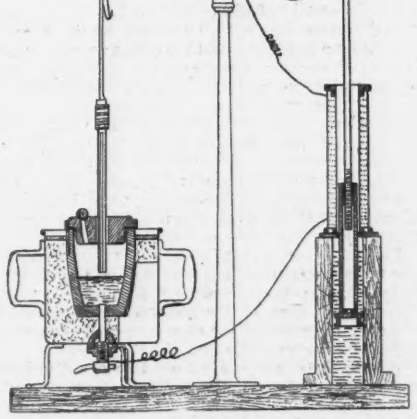


Fig. 3.

its materials. In the form shown, this furnace is necessarily discontinuous, but the complete inclusion and surrounding of its charge give it much advantage. Where contact of the charge with the electrodes is not harmful, it may be possible to make this furnace continuous. There is no reason why a charging and a tapping hole should not be provided, in which case the run might be sustained. The natural use of a furnace of this type is for the

* Mr. Hutton's experiments have lately been described in a paper read before the Manchester Literary and Philosophical Society.

production, at a high temperature, of metals, alloys, carbides, and similar fluid bodies which are too conductive to allow of easy heating in a resistance furnace. The application of the high heat of combination of aluminium to the reduction and fusion of refractory

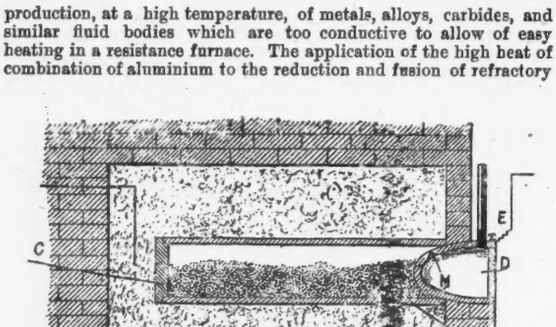


Fig. 4.

metals limits the utility of this class of furnace, and at the present moment it is used only in one industry with which I am acquainted, and then in a modified form. I refer, of course, to the manufacture of CaC_2.

A typical resistance furnace is that devised by Borchers, and shown in the figure (fig. 2). It consists of a slender carbon rod, A, supported between two stout carbon rods, B B. The small rod bridges the cavity, C, which can be filled with the material to be treated. On passing a sufficient current the rod is raised to a high temperature, and the charge is heated from its very centre. This class of furnace is evidently generally adaptable, provided that the product of the action of the high temperature, *e.g.*, a metal, does not collect and form a good conducting connection between the large carbon rods. The type is represented by the furnace employed for the manufacture of carborundum.

These two types of furnace, viz, that in which there is a definite arc, and that in which the heating is effected through a core of high resistance, or the charge itself, will be found to represent in one class or another all the industrial furnaces about to be described

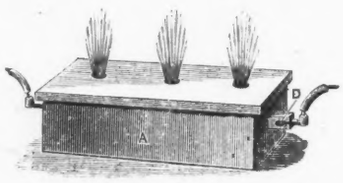


Fig. 5.

In his paper, about 20 years ago, before "The Society of Telegraph Engineers," Siemens laid down with clarity and precision those principles on which the successful operation of the arc furnace depends. He proceeds successfully to experiment, and states:—"In working with the modified medium-sized dynamo machine, capable of producing 36 webers of current with an expenditure of 4 H.P., and which if used for illuminating purposes produces a light equal to 6,000 candles, I find that a crucible of about 20 centimetres in depth immersed in a non-conductive material is raised up to a white heat in less than a quarter of an hour, and the fusion of one kilogramme of steel is effected within, say, another quarter of an hour, successive fusions being made in somewhat diminishing intervals of time." He finds that there is an efficiency of 33 per cent., by no means a bad return in so small an apparatus. The electric furnace has, he says, the following advantages in its favour:—(1) "That the degree of temperature attainable is theoretically unlimited; (2) that fusion is effected in a perfectly neutral atmosphere; (3) that the operation can be carried on in a laboratory without much preparation, and under the eye of the operator; (4) that the limit of heat practically obtainable with the use of ordinary refractory materials is very high, because in the electric furnace the fusing material is at a higher temperature than the crucible, whereas in ordinary fusion the temperature of the crucible exceeds that of the material fused within it." The Siemens electric furnace had the electrodes arranged vertically as shown in the accompanying drawing (fig. 3).

As the charge fused, the arc played between it and the upper electrode. The regulation of the position of the upper electrode was effected by a solenoid and dash-pot similar to the arrangement then in use for arc lamps. A later pattern had the electrodes inserted through the walls of the crucible horizontally. The Siemens furnace does not seem to have received the application which its inventor had reasons to expect, viz., the industrial fusion of refractory metals, and it does not appear to have been adapted to the reduction of their oxides and the preparation in this manner of refractory metals such as chromium and tungsten in reguline masses. But little more of importance was done in the development and application of the electric furnace until 1884, when the Cowles furnace was invented. This was a resistance furnace, but instead of there being a continuous rod of carbon bridging the space between two massive conductors, also of carbon, as in the typical resistance furnace due to Borchers, and illustrated above, the Cowles furnace used the charge itself as the resistance material. How this was arranged is shown in the accompanying figures. (Figs. 4, 5, 6 and 7).

The first figure is interesting because it represents an apparatus adapted for the process of zinc reduction and distillation by electrical means—a process which, although certainly rational and

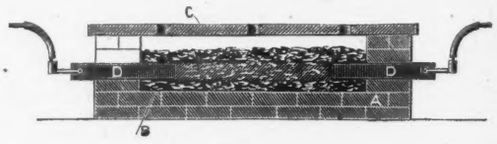


Fig. 6.

probably practicable, has, as far as I know, never been established on a manufacturing footing. The fire-clay retort A is protected from loss of heat by being embedded in refractory non-conducting material B. The charge of zinc oxide and carbon serves as the resistance material to be heated by the passage of an adequate current between the carbon plate C forming the end of the retort and the graphite crucible D, serving both as a closing plug and as a condensing chamber for the zinc distilling from the retort through the side hole M. Gases—*e.g.*, carbon monoxide—generated during the reduction of the zinc oxide escape through the pipe E. No account has come to my notice of the reason which prevented this furnace being brought into use. It is probable that it failed because of the difficulty of so preparing the charge that it should consist on the one hand of a mixture of zinc oxide and carbon intimately mixed for reduction, and on the other should constitute a granular semi-conductive mass suitable as a resistance material, and capable of being uniformly heated by the passage of the current. Further, it is evident that as the charge was worked off, its composition and physical structure would be progressively altered by the distillation of the reduced zinc, and the removal of an equivalent of carbon as carbon monoxide and its electrical resistance would therefore be continually varying; a large excess of carbon would in any case be necessary, for otherwise towards the end of the run one could hardly hope to have a continuous uniform semi-conductive bridge between the two carbon ends of the retort. Such working difficulties may well have caused the abandonment of the process and have delayed the realisation of a promising application

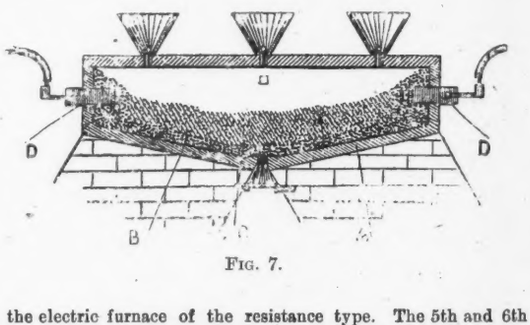


Fig. 7.

of the electric furnace of the resistance type. The 5th and 6th figures represent in perspective and in section the familar form of what is commonly known as the Cowles furnace. A modification less well known is shown in fig. 7. The essentials of both are the provision of a core of resistance material consisting of a mixture of ore with carbon to serve the double purpose of conduction and reduction, and the surrounding of this core with a material highly refractory, and at the same time a bad conductor of heat and electricity. Such a material is granular charcoal. In the drawings shown similar parts are indicated by the same letters. A is a firebrick casing, B is the protecting layer of granular charcoal, and C is the semi-conducting charge. The carbon conductors, by which the current is led into the furnace, are shown at D D.

(To be continued.)

ELECTRIC SHOCKS.

In the course of the Institution discussion on the "Electric Shocks" papers, Mr. Michael B. Field, of Glasgow, communicated the following remarks:—

"I am heartily in sympathy with the attempt which Mr. Trotter has made to allay the misapprehension under which the non-technical press and the man in the street labour as regards the dangers inherent in 500-volt shocks. Nowadays it is not altogether an unusual occurrence for one to overhear, perhaps in a railway train, at a restaurant, or elsewhere, some non-technical wiseacre, while dilating upon the mysteries of electric traction, explain that if anyone should be so foolish as to touch the third rail he would be

instantly reduced to a charred mass; or, failing that, make some other equally extravagant statement as to the inevitable result of a momentary contact with a 500-volt main.

"Mr. Trotter's paper will, I hope, do much to remove such exaggerated notions; but I am almost afraid some, after reading the paper, may be inclined to rush to the opposite extreme, and consider that the dangers of 500-volt circuits are merely mythical.

"Mr. Trotter says, for example, on page 6, 'Neither a man in the street nor a man on the car runs any risk in taking 500 volts skin to metal.' Personally, I do not like to see such statements published by an eminent authority without a caution being appended. As I shall afterwards show, I consider a very great risk *might* be attendant upon such a procedure. Mr. Trotter goes on to say in explanation that he has frequently grasped a live trolley line in both hands from the top of a car. This may very well be done without feeling a shock, seeing the car itself in dry weather insulates the experimenter very perfectly. Grasping the hand-rail and flicking the trolley wire with the finger (supposing the hand-rail grounded) is to most people a painful operation, though by no means dangerous; but grasping both hand-rail and trolley wire, skin to metal, will, I think I might say, in 75 cases out of 100, give a shock of sufficient severity to render the experimenter powerless to release his grasp—and therein lies the danger—a point not brought out by Mr. Trotter.

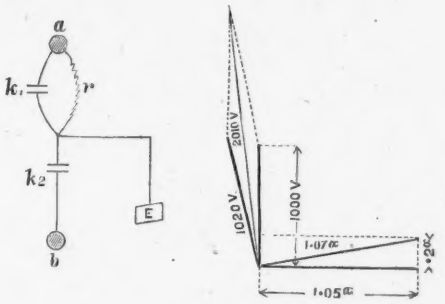


Fig. 1.

"The danger to life involved in a shock is not solely dependent on the voltage. Cases of shock at 250 volts and less have been known to prove fatal; while others at 5,000 have not been attended with loss of life. The question as to whether a shock will prove fatal or not is probably decided by a large number of factors—1st, the physical peculiarities of the subject; 2nd, the strength of current traversing the body; 3rd, the path traversed; and 4th, the duration of the shock, &c. I should be inclined to make the following classification of shocks:—

"(*a*) Painful, but not dangerous.—When two metallic bodies (*e.g.*, terminals) are grasped one in either hand, but the potential difference between them is sufficiently small to allow of them being voluntarily let go again; or when the body is momentarily placed in circuit with a moderate * voltage without grasping, or in such a way that grasping is impossible.

"(*b*) Dangerous if prolonged.—When the potential difference is sufficiently great that the hands involuntarily grasp the terminals if they touch them, and the victim is powerless to open the hands, though able to cry out intelligently or otherwise.

"(*c*) Dangerous, though not necessarily producing immediate unconsciousness.—When the potential difference is still greater, so that while it is impossible to release the grip, the victim is unable to utter any cry whatever.

"(*d*) Very dangerous, unconsciousness ensuing immediately on contact.—Considerably higher potentials than foregoing; momentary contact produces unconsciousness and perhaps death.

"It is impossible to lay down limits of voltage for the above cases—they depend so much upon circumstances and individuals—but I will instance here a few typical cases that have come to my knowledge:—

"1. I have seen a man writhing with his hands grasping two wet water plates with only about 80 volts between them. He could not release them, but shouted intelligible instructions.

"2. I myself received a very severe shock from a 2,000-volt alternator running excited. I doubt if it were giving as much as 200 volts. I was standing on the top of a concrete wall forming part of a reservoir, in very powerful sunshine. My left hand came quite accidentally against a wire leading to a water resistance dipping into the water, and it immediately gripped the wire firmly. I was powerless to release my grip; but running along the wall I sprang down (about a 5-ft. drop), by which action I tore myself free of the wires. While in contact I could distinctly feel the current, first in the right, then the left leg, at each step. I shouted, but could give no clear directions.

"3. A man standing on fairly dry ground was unable to release the handle of a fuse box which had become alive from a 500-volt tramway circuit. He shouted and was pulled off.

"4. A linesman standing on the handrail of a car was unable to release a trolley wire at 500 volts he had gripped. He shouted and was pulled off.

"5. A man tripped over a coil of wire, and made contact for an instant with the brush gear of a 550-volt machine. The contact was only momentary, for, as he lay on the floor, he was quite clear of the machine. During his fall the brush holder had, however, scratched and entered the skin of the neck, and such a severe shock resulted that resuscitation methods were resorted to for nearly half-an-hour before any signs of life were manifested.

* Perhaps up to 800 volts.

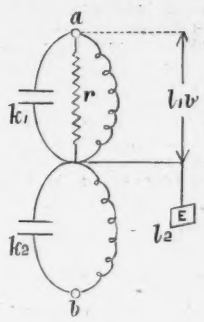


Fig. 2.

"6. A few years ago I saw a poor fellow who had been killed by 2,000 volts alternating. He uttered no cry (as far as I could ascertain), but stood stiff and erect, grasping the fatal switch which had become alive, for fully half a minute until the circuit was broken, when he instantly collapsed.

"It should be borne in mind that moderately low voltages (*e.g.*, 500 volts) may be very dangerous if contact be made at a part of the body where an open sore or cut exists—this may easily be on a workman's hands (*vide* case 5).

"There is one important difference between high-tension direct-current and alternating current systems from the point of view of shocks, and it is this:—

"With a direct-current system, provided both poles be thoroughly insulated, they may be touched one at a time by anyone standing on earth without running the risk of a fatal shock. For example, if the insulation to earth of each pole be 30 megohms and the supply voltage be 3,000 volts, the current flowing to earth through the body, if in contact with one pole, would be less than $\frac{1}{10}$th milliampere. With the same conditions, but with an alternating system, the current through the body might be several thousand times as great. If the amount of underground cable be at all large the insulation resistance of the system plays a relatively small part in reducing the current to earth; for, owing to the capacity to earth of each pole, the body is practically forming part of a circuit of relatively low impedance through which a large current will flow. Take an actual case:—

Supply voltage, 3,000*
Frequency, 50.
Capacity of each pole to earth, 3·33 microfarads.

The capacity current will be in this case 1·57 amperes.

"Now, connect a resistance of 5,000 ohms, representing a human body, between earth and one pole, fig. 1:—

"Assume for the time being pole *a* is 1,000 volts above earth; the current through *r* will be ·2 ampere, and through k_1, 1·05 amperes. The resultant will be 1·07 amperes. This flows through k_2, and therefore *b* will be 1,020 volts above [? below] earth. Combining these two voltages, as in fig. 1, we find the P.D. between *a* and *b*, is 2,010 volts.

"Or, if we take the supply voltage at 3,000 instead of 2,010, the current through *r* will be proportionately increased, viz., to ·298 ampere; that is to say, as far as prevention of shocks is concerned, the insulation of the cable is only equivalent to about 5,000 ohms to earth, though in reality it may measure 30 megohms, or more.

"It is, of course, theoretically possible to neutralise this capacity effect in the usual way by connecting a corresponding self-induction in parallel, as in fig. 2.

"If these were perfect capacities and self-inductions, the current through k_1, l_1, and *r*, would be zero; whereas, through k_2 and l_2, comparatively large currents would flow in opposite phases; *v* would likewise be zero. It certainly seems remarkable that, although no current whatever flows from *a* to earth either through k_1, l_1, or *r* (representing the human body), an appreciable current is flowing between earth and *b* in each of the circuits k_2 and l_2.

"Of course, this method of connecting self-inductions between the mains and earth to overcome shocks is not really practicable; firstly, because it is not possible to obtain sufficiently pure self-inductions and capacities, *i.e.*, devoid of dielectric and magnetic hysteresis, ohmic losses, &c.; secondly, true compensation is only obtained at a given frequency, and if this frequency be departed from by only a small percentage, currents of fatal magnitude would probably traverse the resistance *r*.†

* A single-phase case is taken by way of example, though such systems would usually employ concentric cables with the outers earthed.

† If *k* and *l* be arranged to neutralise each other at a frequency *n*, then the combination of *k* and *l* for a frequency $n + \delta n$ is equivalent to merely a single capacity of value *k*, but working with a frequency $2\,\delta\,n$, instead of $n + \delta n$ if δn be positive, or to a single self-induction of value *l* with a frequency $\frac{n^2}{2\,\delta\,n}$, if δn be negative.

"Coming now to a more practical point, I would like to touch upon the treatment of those rendered unconscious by electric shock.

"It is well known that in cases of collapse, such as result from severe electric shock, it is highly beneficial, and sometimes imperative, to use artificial means to stimulate the action of the heart, such as the hypodermic injection of ether, brandy, &c. Now, it is quite possible that after such an accident, a medical man hastily summoned would not be provided with the necessary apparatus for the treatment referred to above. To meet this emergency, I have hitherto recommended that all high-tension sub-stations and generating stations be provided with a small sealed case containing a hypodermic syringe, together with small phials of the necessary drugs. I might mention that Messrs. Park, Davis & Co. supply aluminium cases, which can easily be carried about in the waistcoat pocket, containing hypodermic syringe, together with hypodermatic tabloids of strychnine nitrate, cocaine hydrochlorate, morphine sulphate, &c. One of these tabloids has only to be inserted in the barrel of the syringe, and the latter filled with pure water, for the apparatus to be ready for use.

"One engineer with whom I was acquainted on the Continent claimed to have saved several lives by the timely injection of ether. The medical profession in England seems, however, to consider it altogether beyond the province of unqualified persons to apply this restorative, and I should be glad to elicit the views on this point of any medical man present to-night."

CURRENT SPECIFICATIONS.

XCV.—GEORGETOWN (PENANG) ELECTRIC LIGHTING.

SUMMARY.

Extent of Contract.—Supply and delivery packed for shipment at port selected by tenderers of electrical plant as follows:—Sec. 4.—Two 100-KW. steam dynamos and balancer booster. Sec. 5.—One main and one sub-station direct-current switchboards. Sec. 8.—Forty arc and 350 glow lamps for street lighting.

Type of Engines.—To be of the vertical compound, two or three-crank high speed type.

Limit of Speed.—Not to be above 400 revolutions per minute.

Range of Governing.—Not to exceed 3 per cent. when three-quarters of load is removed, and no hunting is permissible under any condition of change of load. Momentary variation of speed when full load suddenly thrown off not to exceed 10 per cent. Governor to be capable of adjustment by hand 5 per cent. above and below normal speed while engine is running.

Output of Dynamos.—As compound-wound machines for traction purposes, 182 amperes at 550 volts; as shunt machines for lighting work, 190 amperes at 530 volts. The voltage of machine on open circuit to be 530 volts when working as compound machine.

Specified Overload.—25 per cent. for one hour without injury.

Permissible Temperature Rise.—After 10 hours' run at full load, with 190 amperes in armature circuit, the temperature rise not to exceed 60° F., or in field magnet circuit 70° F. under similar conditions.

Conditions of Working.—Sets to give above outputs with 150 lbs. sq. in. pressure either non-condensing or exhausting into condenser with 24-in. vacuum.

Steam Consumption Guarantees.—To be stated by tenderers

Balancer and Booster.—To consist of four machines mounted on one bedplate, the two inner machines to be capable of dealing with an out-of-balance current of 50 amperes in the middle wire of a circuit with 500 volts across the outer conductors. The two outer machines to generate 75 amperes at any voltage between 15 and 90 volts.

Speed of Machine.—Not to exceed 1,200 revolutions per minute.

Switchboards.—Two to be provided, one for placing in generating station, the other in a battery sub-station, 1¾ miles distant.

Design of Boards.—To be as per details specified and generally arranged as per blue-print sent with specification.

Street Lighting.—40 arcs and 350 glow lamps to be supplied. Posts of an approximate value of £7 each, complete with carrier, are also to be supplied under this contract.

Type of Arc Lamp.—To be of single carbon, self-focussing type, 10-ampere size, suitable for direct currents and for burning continuously with one pair of carbons for 11 hours. An alternative price for lamps burning 20 hours without re-carboning may also be given.

Conditions of Burning.—The lamps are to be run nine in series on a 440-volt circuit.

Glow Lamp Fittings.—Present brackets and posts are to be adapted as far as possible, as suggested on blue print accompanying specification.

Dates of Delivery.—To be stated in tender for each section.

Penalty for Late Completion.—One per cent. of contract sum, presumably for each section per week.

Particulars for Shipment.—To be obtained from Mr. R. M. Christie, 98, Cannon Street, London, E.C.

Dock Dues.—All dock dues payable at port of embarkation to be included in contract price.

Terms of Payment.—90 per cent. within reasonable time of delivery of shipping documents to Mr. Christie; 10 per cent. after delivery of goods in Georgetown, or at latest not more than 12 months from first payment.

Stipulations as to Wages to be Paid to Workmen.—None

Arbitration Proposals.—Satisfactory.

Date for Receipt of Tenders.—April 28th, 1902, at office of Mr. R. Christie, 98, Cannon Street, E.C.

This specification is issued by the firm of Messrs. Preece and Cardew, the consulting engineers to the Municipal Council of Georgetown, Penang, the purchasers of the plant. The present contracts end with the delivery of the several items free on board at British port, the Commissioners undertaking the responsibility of receiving and erecting on site at Georgetown.

It is stated that the climate is almost uniform during the year, the average temperature in the shade being 82° F., and in the sun about 142° F. There is a great deal of dampness in the atmosphere, and the plant supplied must be in every way suited for working under these conditions.

The steam dynamos are to be wound so that they may be used for traction as well as lighting purposes, but at first they will only be used for lighting. It is proposed to place an accumulator sub-station about a mile and three-quarters from the generating station and supply a large part of the distributing network from that point.

The technical conditions to be fulfilled in the generating plant section are clearly stated, and all manufacturing details are left open to the tenderer; it is stated that offers for steam turbine dynamos of the same output will be considered. Two 100-KW. generating units are required now, but it is to be open to the purchasers to order a third similar set within six months from the date of acceptance of contract at a price to be named in tender.

The arc lamps are to be suitable for 11 hours without re-carboning, that being the usual time of lighting per night. At present only 350 glow lamps and fittings are specified, but eventually over 800 will be required.

Great care must be taken to keep the weights of the packages below 1 ton. Within one month of acceptance of tender, detailed drawings of the proposed plant are to be supplied, which must not afterwards be in any way departed from. All plant before delivery is to be tested and inspected by Messrs. Preece & Cardew, or their representatives.

The terms of payment are fair, the arbitration clause may be accepted without demur, and there are no vexatious wages or labour clauses.

THE BOARD OF TRADE REPORT ON THE LIVERPOOL RAILWAY ACCIDENT.

THE reports of Lieut.-Colonel Yorke and Mr. A. P. Trotter on the disastrous fire which occurred on the evening of December 23rd at Dingle Station, on the Liverpool Overhead Electric Railway, whereby six lives were lost, has been issued. After giving a detailed description of the occurrence and of the line itself, the Colonel refers to the sleepers which caught fire, as follows:—

"It is easy to be wise after the event, but I do not consider that any blame can be fairly laid upon the company for storing some sleepers in a corner of a wide tunnel such as this for the purpose of repairing and maintaining the permanent way in and near the station. In future, however, no timber of any sort will be allowed to remain in the tunnel, except the sleepers actually laid in the permanent way."

He concludes as follows:—"The cause of the fire is explained in Mr. Trotter's report. It was due to a defect in one of the motors, and would have been productive of no serious danger if driver Ashbee had only acted with a moderate degree of prudence. When this man discovered that his rear motor had failed, his duty was to disconnect the rear motor by means of the plug provided for the purpose in his compartment. He should then have run into the station with one motor, as is often done. . . . . The circumstances connected with this fatal occurrence direct attention to the advisability of removing all woodwork as far as possible from the neighbourhood of the electric machinery upon railway carriages, and of adopting for the purposes of insulation some material which is uninflammable and smokeless. This subject is dealt with in Mr. Trotter's recommendations, with which I entirely agree. It is to be hoped that the engineers connected with electrical railways will act upon Mr. Trotter's valuable suggestions. Stations situated in tunnels on electric railways should have as little woodwork about them as possible. The platforms should be of stone or concrete, and buildings such as signal-boxes of brick or iron. I am glad to be able to report that the Liverpool Overhead Railway Company have adopted this principle in reconstructing Dingle Station, there being now practically no woodwork at all about the place."

Mr. A. P. Trotter reports:—

"The evidence goes to show that the insulated covering of a cable connected with the motor on the after part of the train had become deteriorated. The wet weather may have contributed to the defect, and, as the train was late, the driver may have forced the speed. The insulation broke down, an electric arc was started, the rush of current opened the automatic circuit-breaker, and stopped the train. The driver reset the circuit-breakers and tried to start several times, and the arc broke out each time, causing the flashes. It is not unlikely that the driver held up the circuit-breaker, for the lights "went low," showing that a very heavy current was being taken. The arc, due to this heavy current, or,

perhaps, the earlier flashes, set fire to the woodwork of the coach, and the strong wind caused the fire gradually to spread.

"The opening of a circuit-breaker is a common occurrence; the driver should have disconnected the rear motor, and should have run in with one motor. In cases of breakdown of one motor, the journey is often thus completed. Motors and the connecting cables on electric railways and tramways often break down through the failure of the insulation. The possibility of a panic from smoke arising from such failures on tunnel railways has been foreseen, and must be guarded against, but eight years' experience on this railway has shown that such failures, even when resulting in a 'burn out' of a motor, have never before set fire to any part of the train. The risk of fire involved in the present railway, on which there is but one short terminal tunnel, was less than on ordinary steam railways.

"This railway is one of the pioneer lines, on which the earliest American and other electric railways were afterwards modelled. The motors are identical in pattern with those first fitted in 1893, but the parts have been gradually replaced as they wore out. The motors are overhauled about once for every 30,000 miles run. The armature of the motor, to which the accident is attributed, was re-wound in February, 1896. Since then it has been overhauled and repaired, if necessary, 11 times, and since February, 1896, has run 153,571 miles. The magnets were re-wound in September, 1899, and were specially overhauled in December last. A train had been fitted experimentally with modern iron-clad motors, adapted for higher speeds than at present, but the absence of iron casings in the present instance is not an essential matter.

"*Recommendations.*—Flexible cables covered with india-rubber or other combustible material are used unnecessarily in many cases in electrical work. They are a survival from the earliest branch of electrical industry, namely, telegraph work. They are used from habit and for convenience. This mode of construction does not commend itself to mechanical engineers. Combustible insulating materials should not be used on the main current conductors of electric trains, particularly in tunnel railways. These conductors should be rigid, and might be bare, or enamelled, or protected by incombustible ferrules in iron pipes. Flexibility should be restricted to necessary points, and not used for convenience in arranging the conductors. Flexibility should be provided by pinned hinge or knuckle joints shunted by bare flexible links of wire gauze, or cable braided with wire, or by some other sound mechanical mode of construction.

"Little or no woodwork should be used in the construction of electric locomotives, or of the drivers' cabs of motor coaches, and in the latter, the resistances and the controlled switches should be placed, if possible, in front of and outside the cab."

TUNBRIDGE WELLS TELEPHONES.*

(*Concluded from page* 495.)

Mr. Drury then addressed the Inspector. The opposition was called factious, but they were not people with their own axes to grind. They had large interests in the borough, and they demanded that in such a hazardous undertaking more time should elapse before enlarging the scheme. They wanted more experience before extending it, and in view of the keen competition they objected to a further £15,000 being speculated until the undertaking had been fairly tested. That was a very reasonable proposition. It was said that the original loan was not opposed, but the difference between a loan of £10,000, and then wanting another £15,000 in six months, was a very different thing. It was now admitted that a third loan would before long be wanted. Was not that a reason for ratepayers waking up, when they learned these facts, which they were not told in the first instance? Was their opposition to be wondered at, when they found out what they were being committed to? The telephone only benefited a small number. It was not a matter for public health, like electric light or water. Then the ratepayers would have to pay the loss on the outside districts, where expenses were heavier. Was it surprising that the outside districts came to that Inquiry to support the application, to give them telephones without any liability, which was to be paid by Tunbridge Wells? The whole loss would fall upon the borough, and that did not appear to be sufficiently realised. It was a case of "heads I win, and tails you lose." Then Tunbridge Wells came to the Local Government Board, and said they had spent the money before applying for the loan, and therefore the loan must be granted, or the loss would fall on the rates. That was a most unusual proceeding which the Local Government Board would censure, and Mr. Cripps was not correct in saying that the cost would fall on the rates if the loan were not granted, because he thought the auditor would never allow an illegal expenditure to be charged upon the rates. An argument like the Corporation used was simply a gambler's argument. The Corporation said you must spend more money, or lose what you have spent. If the system was likely to incur an annual loss, surely it would be better to limit the loss, and not go on extending it. They must not cover their losses by further expenditure. If there was to be municipal trading, let it be in an undertaking which benefited the general body of ratepayers; at any rate, in something where there was a reasonable prospect, if not of making a profit, of not involving the owners in a loss. Would any private person invest £25,000 in the Tunbridge Wells Municipal Telephone Exchange after the evidence they had heard? They had a hazardous undertaking, and it was only reasonable to inquire whether the Corporation were acting as an ordinary business man would do. As Lord Londonderry had said, they should consider local conditions. This was not a commercial town at all.

Mr. Cripps: It is one of the three most wealthy residential towns in the kingdom.

Mr. Drury said he represented a number of the wealthiest inhabitants who objected to the Corporation scheme, and who had got eventually to pay the losses on this scheme. They had not only a speculative undertaking, but powerful opposition. How was the Corporation to fight a powerful company, except by continually coming to the Local Government Board for more money? The Corporation not only fought the National Company, but were fighting the ratepayers who found the money. The Corporation boycotted ratepayers who found the money for the undertaking. Ratepayers were cut off from the police and fire services, which they paid for. Because they found the National service the best, was it right for a Corporation to put pressure on to its ratepayers, to boycott them, and compel them to give up the National for the municipal system, which might not have on the people they wanted to speak to? Was that legitimate or honest in a public undertaking, whatever might be permissible in private undertakings? What must be the result of competition? He quoted what the Postmaster-General said—that competition was not applicable to telephony. Competition, instead of co-operation, meant that people subscribed to both systems, or could only speak to half the people they otherwise would. A tradesman found that if private residents had the National telephone, he must have the National as well as the municipal telephone, and they also had the disadvantage that in other towns the National Directory was in use, and if they were municipal subscribers, their numbers could not be ascertained in other towns. Then competition meant that the Corporation would have to spend more than they otherwise would on their plant, and no allowance was made for that. They would have to keep their plant up to date or succumb to the competition which provided a better service. He now came to Mr. Bennett's estimates. A reference had been made to Mr. Bennett's remuneration, and he could not help saying it was extremely unfortunate that the engineer advising the Corporation was a gentleman whose remuneration depended on the adoption by the Corporation of his scheme. The expert consulted by the Corporation should be independent of interest in getting his scheme adopted, and so ensuring the payment of his fees. He suggested to Mr. Bennett that the experience of Tunbridge Wells would be the same that Manchester had of Mr. Bennett. They had inferior and cheap plant, and the end was obvious. It was because of this that Mr. Bennett was not a satisfactory adviser. He cut down his estimates to get them adopted, and they had it in evidence that Mr. Bennett made gross mistakes.

Mr. Cripps protested.

Mr. Drury said he was quoting the evidence of Mr. Forbes, who, said Mr. Bennett, was not a credible person on telephone matters. Mr. Bennett's estimates were not reliable, and they had to find that out in Tunbridge Wells as they did at Manchester. Mr. Bennett's estimates worked out in practice greatly in excess, and his plant was of a flimsy and trumpery description. He was quoting the evidence of experts at Manchester. Were they going to take Mr. Bennett's word in Tunbridge Wells against the opinion of experts elsewhere? Mr. Sinclair, who said the plant was flimsy, was a liar according to Mr. Bennett, though at the Glasgow Inquiry he was believed. They had the reports on Mr. Bennett's plant, and Mr. Bennett might deny it, or consider that everyone else but himself was a fool, but the opinion of experts on Mr. Bennett's work in other parts of England must have weight. Even Sir Wm. Preece, so Mr. Bennett said, did not know what he was talking about, when Sir William said that Mr. Bennett's system was cheap and nasty. Sir William had advised the Tunbridge Wells Corporation, and was an acknowledged authority, but, according to Mr. Bennett, he did not know what he was talking about. It was still more curious that Mr. Bennett's memory failed him when he was questioned about his estimates, which were only six months old. He thought they would prefer Sir Wm. Preece and the other experts to Mr. Bennett, who cut his estimates to the lowest figure, and then forgot what he had estimated. When questioned Mr. Bennett resorted to extraordinary expedients to make his estimates meet, and get them accepted by confiding corporations. He was pleased he had had the advantage of expert evidence which had a restraining influence upon a person like Mr. Bennett. The evidence he had called had, he submitted, compared very favourably with that given by Mr. Bennett, who had so often refused to answer questions put to him. He understood Mr. Bennett got over the absence of a contingency fund by saying he would provide this out of profits; but if the profits proved imaginary, how was that to be done? Mr. Bennett chose to ignore damage from snow-storms, &c., notwithstanding the evidence they had on that point. He could not help pointing out what different opinions Mr. Bennett held when he was giving evidence against the National Company, and when he was giving evidence in support of his own cheap scheme. Giving evidence at Glasgow, Mr. Bennett had a great deal to say about the expense of an overhead system, and at Tunbridge Wells his evidence was exactly the opposite. Such astonishingly opposite evidence could not be reconciled. Mr. Bennett evaded the point by a childish juggling. He was driven from point after point, and at last relied on profits which did not exist, to provide for contingencies he had not provided for at Tunbridge Wells, but which at Glasgow he held to be necessary. As to depreciation, Mr. Bennett could not provide for this out of profit. The evidence they had heard that morning showed undoubtedly that three times in the course of 20 years telephone plant had been practically renewed, but Mr. Bennett left that to be paid for anyhow, except by prudent provision. Experts were agreed that there should be the depreciation

* Reported in the *Kent and Sussex Courier*.

fund, which Mr. Bennett omitted in Tunbridge Wells for the sake of cheap estimates. The evidence of Mr. Kingsbury was unquestioned, notwithstanding Mr. Bennett's hurried whispers to Mr. Cripps; and it was evident that Mr. Bennett was unable to suggest to Mr. Cripps how he could shake Mr. Kingsbury's evidence in cross-examination. He asked the Inspector to accept this unquestioned evidence, instead of Mr. Bennett's cheap estimates and arbitrary calculations made to suit himself. As regards the six months' working, it was suggested that this was the most crucial period, but really it was in this period that they would have no allowance for the repairs, which would come later. The crux of the whole question of Mr. Bennett's estimates was as to spare lines. They had not had an intelligible explanation from Mr. Bennett, whose evidence was so contradictory respecting his own system that they did not know now whether there were any spares. Knowing that Mr. Bennett's estimates would be questioned, the Corporation had no evidence to support the forgetful Mr. Bennett. They were still in the dark on Mr. Bennett's position, or how the future would be provided for. If Mr. Bennett had neglected this provision, away went £1,300 of the income, which the town clerk talked so much about. Therefore, the spare lines which Mr. Bennett told them so little about were the crux of the whole question. What became of the borough accountant's profit if Mr. Bennett had not provided spare lines and depreciation? There was a loss instead of a profit to the ratepayers. Had they ever heard of an engineer, except Mr. Bennett, who forgot to provide £500 worth of instruments, and wanted to put this and everything else he had not provided down to sundries? A contingencies item was left to cover everything which had been neglected. That incident alone would discredit any estimate of Mr. Bennett's now and hereafter. Telephone instruments were not provided for by something like £500, and it was proposed to supply that by falling back on the contingency fund of £1,200.

Mr. Cripps: That is an admitted point.

Mr. Drury: No one ever saw an estimate put forward by a person considered a competent engineer who had to resort to that practice to get out of a difficulty. Here was plant absolutely unprovided for at all. Had Mr. Bennett carried out his promise to give Tunbridge Wells a first-class up-to-date system? They had evidence that the ratepayers would be disappointed. When had Mr. Bennett told them that his switchboard was insufficient, and he would want more money to provide a proper switchboard? They had a number of defects, which all militated against an up-to-date system. They had cables laid in the earth which prevented economical working in the future, because conduits, as used elsewhere, meant less working expenses. Then the press-the-button and ring-the-bell instruments were not part of an up-to-date system Mr. Bennett promised them. Contrast the automatic system of the National Company and the clumsy system of Mr. Bennett, and the inconvenience caused to subscribers who forgot to press the button. Mr. Snowdon did not pretend to have made an exhaustive inspection. What he might have found if he had done so he would not venture to say, but Mr. Snowdon saw enough in his brief visit to see that this was a cheap system which had been rushed up, and would cost a great deal to make it efficient in the future. The ratepayers must be prepared for a large outlay in the future to make up for Mr. Bennett's cheap estimates. Coming to the accounts, the figures put forward were simply estimates, and those put forward by Mr. Bevan were equally entitled to consideration. He wished to point out that the borough accountant was largely dependent on Mr. Bennett's figures in arriving at his results, and these figures had already been contrasted with the figures which Mr. Bennett had given at Eastbourne. If Mr. Bennett's figures were true in November, they ought to be true in January, but he wished to say that he did not question the borough accountant's figures, but Mr. Bennett's figures. Assuming that accuracy lay half-way between experts, what became of the municipal undertaking? Let them correct Mr. Bennett's estimates even to half the extent suggested, and what became of his cheap scheme? Not only was the profit gone, but the expenditure had to be largely increased. That being so, the undertaking must be a ruinous one for the Corporation. It was said that the opposition would be in the interests of the National Company, but that had nothing to do with the point.

The Inspector: I quite agree with you.

Mr. Drury said that if the result would benefit the National Company, it would be better it should do so than that it should be disastrous to the ratepayers, who, without sufficient advice, had embarked in this hazardous undertaking.

Mr. E. E. Robb then rose to address the Inspector. He said he would like to thank him for the great patience and impartiality with which he had presided over that long inquiry. He thought some apology almost was due to him for the demands made upon his time, but he would like to point out that the inquiry was exceptionally important, because Tunbridge Wells was the only borough in the whole of England which had, at the present time, an established telephone system in effective competition with the National Telephone Company, so it must be apparent the inquiry was immensely important, and one having wide-reaching results. Firstly, there was the question of policy, and he maintained that the Corporation of Tunbridge Wells was not carrying out the policy that the Government had in view when they passed the Telegraph Act, 1899. It had been said by the present Postmaster-General, Lord Londonderry, who might fairly be claimed to represent the Government in this matter, and the Committee of 1898, that the Government, in passing the Act, never contemplated a war of rates, and never contemplated any such competition—cut-throat competition he advisedly called it—as was going on in Tunbridge Wells at the present time. The Postmaster-General, in his speech when he was approached by a deputation of the London County Council, said that the system that the Government and the Committee had in view might fairly be described as a system of competition, tempered with a certain element of co-operation, as was necessary for the due protection of the public. All the advantages of both systems (Lord Londonderry was speaking of London where there was co-operation between the Post Office and the National) were placed at the disposal of all subscribers. Any person reading the report of the Committee must come to the conclusion that it was this kind of competition that the Government had in view, and he would further remind them that it was the same kind of competition which the Act of 1899 desired to promote. If it be true that the Corporation of Tunbridge Wells were not carrying out the intention of the Government, that was a question which the honourable Board, of which the Inspector was representative, were entitled to take into consideration. It must be obvious that, if they were to have competition, it ought to be competition on such a fair arrangement that there might be intercommunication between the two systems. It was true the competition would tend towards an increase in the efficiency of both services, and it was also true that unless they had inter-communication between the two systems, 50 per cent. of the subscribers on each system had to be subscribers to both. That could not be of any benefit to the public, because it entailed additional expense upon the subscribers, and in addition, produced chaos and confusion. As a matter of fact, they had from the first consistently opposed the matter, because they considered that if the Corporation of Tunbridge Wells wanted to put their money into enterprises and devote their energy to enterprises there were many things of much more pressing and urgent need than a telephone system. He had always urged that telephony, strictly speaking, was an Imperial and not a municipal business, and that the messages would sooner or later have a tendency to circulate more throughout the country than through the local or district area. Further, it was a class business; it was a luxury that could only benefit the few and not the many, such as gas or water would do. He quite agreed if this telephone was to be a success anywhere it would be at Tunbridge Wells. It was abundantly proved that Mr. Bennett, notwithstanding what they were led to believe in the first instance, could only give them a skimped and cheeseparing system. There was a significant point in Mr. Bennett's report, which he was sorry Mr. Cripps had not put in to the Inspector. It would enable him to form a better idea of Mr. Bennett's singular methods. The most appropriate illustration he could give of Mr. Bennett was that of a jumping frog. He caught them with the bait of a very low estimate and then his estimates kept on jumping up, and from his admissions in the witness-box he had not ceased jumping yet. It was impossible to say in what expenditure Mr. Bennett would ultimately land the Corporation believing in his cheapness. He need not remind the Inspector of how Mr. Bennett's estimates had been exceeded. But the most important point was that of spares, because on this point the whole of the delightful balance-sheet, which had been presented to them, disappeared into air. When Mr. Bennett was in the witness-box he was very uncertain about how many spares he would have. When he was pressed, he declined to pledge himself, and it was very advisable on his part. Mr. Bennett's estimates showed an error of 20 per cent., and for an engineer that was a very serious error indeed. He would go further than that, and predict that when all this £25,000 was expended they would not have the 1,148 completed lines. It had yet to be proved, and it was not proved at that inquiry, that Mr. Bennett would verify his estimate in the result. The Corporation had spent their £10,000 loan; they had spent £9,320 in excess of that loan, and, according to their own estimate, which was a sanguine one, they would only have 533 completed lines on which revenue could be estimated. That was all the Corporation had for their £19,320. When the latter half of the expenditure was incurred they could expect that Mr. Bennett's estimates would be as much exceeded as in the first half. They had to find out Mr. Bennett's estimates by experience of them. He had already quoted Mr. Bennett's report to the Brighton Corporation, in which he condemned out of his own mouth what he was doing at Tunbridge Wells. He told the Brighton people that there must be unproductive lines, but at Tunbridge Wells he estimated all lines as revenue-earning to get a balance. They could only regret that Mr. Bennett had not told the Tunbridge Wells people what he told the Brighton people. It would have been useful to have had the information a little earlier. It was claimed by the borough accountant, who, of course, took his figures from Mr. Bennett, that all lines could be reckoned for revenue. His friend, Mr. Cripps, did not try to elucidate this point in the light of the very different story Mr. Bennett told at Brighton. Neither did Mr. Cripps venture to cross-examine Mr. Kingsbury on this point, although it made all the difference to the success or otherwise of the Tunbridge Wells undertaking. Then they had the evidence at Glasgow of Mr. Webb. He knew the question was one which Mr. Cripps was anxious to avoid, but the fact remained that Mr. Bennett had not acted in Tunbridge Wells on the evidence he gave at Glasgow. The Corporation, by the absence of a due proportion of spares, might be put to an extravagant outlay to provide a few extra lines which ought to be allowed for in the spares. It had been given in evidence, and he challenged Mr. Bennett to show the contrary, that there was no telephone system in the world without a proportion of spares, except Mr. Bennett's system in Tunbridge Wells. Mr. Cripps had not attempted to controvert the evidence on this point, although it was fatal to the Corporation system.

The Inspector: You cannot overload them like electric light or water mains, to the detriment of the consumer.

Mr. Robb said that was so. There was no telephone system in the world working with less than 25 per cent. of spares. Make an allowance of 25 per cent. for spare lines, and away went the estimates of revenue—that nice little profit which elicited the applause of the telephone enthusiasts disappeared. It had been shown that the proper object of a sinking fund was

to relieve the ratepayers of capital liabilities, and if a municipal undertaking could not earn 6 per cent. like a concern on a commercial basis, it was not worth entering upon. Mr. Bennett blew hot and cold. He told them that a telephone system was one of huge profits, and yet he could not provide for ordinary capital contingencies. He thought the Inspector would accept the evidence that what had been the telephone experience in the past would be the telephone experience in the future, notwithstanding the fact that this experience did not bear out Mr. Bennett's estimates, which he suggested were the estimates of an engineer who wanted Corporation fees. Mr. Bennett himself admitted that the wicked National Company took out its plant before it was worn out, and replaced it by new and improved plant, but yet he did not provide for the Corporation system to be maintained with similar efficiency. How was Mr. Bennett going to avoid an expenditure, which was demonstrated to be necessary, unless they were to put up with an inefficient and more or less antiquated service, which would become more obsolete as time went on, unless replaced? He passed from the engineering to the financial aspect. Here Mr. Bennett's estimates did not bear investigation, because they had a mass of expert evidence that the peculiarity of the telephone business was that the more it grew the expenses increased in proportion, instead of decreasing. Then there were items of working expenditure, but Mr. Bennett omitted that altogether. Other items had been under-estimated. There was the item of waste. A line might be run to a particular house which the tenant shortly afterwards quits. That line remained dead and unprofitable. The allowance for switch rooms was ridiculous. Mr. Bennett's idea of a branch switchroom was a cottage in which a poor woman held a baby in one arm and manipulated the switchboard with the other, while the rest of the family had the small accommodation of a cottage lessened by rooms being taken for exchange purposes. Employers' Liability, insurance, and wayleave removals, were all instances of matters omitted entirely from estimates which must be cheap if nothing else. They were to incur all the risks of fighting a powerful company with their equipment cut down to the most cheeseparing limits. For the Corporation had entered on a cutting competition in preference to the wiser policy of the Post Office of co-operation in the public interest, which would have saved them all the nuisance and expense of two systems. He took it these were the proper lines of competition described by the Postmaster-General. It must be co-operation, and not a war of rates, which was no good to anyone. His friend had referred to the £4 rate of the National, and he said that, as business people, the company were not likely to run the concern at a loss. He did not know whether they did or not, and further, did not care. But he did suggest that the £4 rate was a fighting rate. It was a rate for this particular locality for forcing the hands of the Corporation, and it was not a serious matter for the company to lose a thousand pounds in Tunbridge Wells. He submitted that the time had arrived when the members of the Corporation—notwithstanding the applause of gentlemen outside, who did not really know anything about the question—should take a proper course, and instead of being driven like a lot of sheep by outside members of the public, do the thing that was expected of them, and lead public opinion. The time had now come when it must be seriously considered whether it was right to continue the service. He was sure the Corporation was composed of such intelligent men that if they did come to the conclusion that the system could not be successful, they would do as far as in them lay to remedy any error in which they had, perhaps unwittingly, fallen. He maintained that Colonel Holland had not been misled by anyone. He would rather suggest that the Corporation had been misled, perhaps unwittingly, by his friend, Mr. Bennett. He was not going to say anything unkind about Mr. Bennett, but there was a danger that gentlemen in Mr. Bennett's position were apt to be too passionate advocates of certain schemes, and a little too undesirous of advising the Corporation in the course it would be best to pursue. There was an absence of independent expert advice. In conclusion, Mr. Robb repeated his thanks to the Inspector for the manner in which he had presided over the Inquiry.

Mr. Cripps then replied on behalf of the Corporation. Having heard both the counsel and Mr. Robb, it might be assumed that all had been said that could be said for the opposition. This was only the second or third inquiry of the kind, and he was prepared to meet the opposition on the ground of principle which they raised. Mr. Robb had laid down two principles—one of fact, and one of deduction. Mr. Robb told them that Tunbridge Wells was the only town with an efficient municipal exchange. He also agreed with Mr. Robb that if the exchange could not be made a success in Tunbridge Wells, it could not be a success anywhere. The Select Committee considered the Post Office should either grant licenses or provide a system themselves. As the outcome of that, Councils were authorised to borrow money for telephonic purposes. Mr. Robb had quoted the Postmaster-General in favour of co-operation. He would only say that the Corporation were acting under a Post Office license. He agreed that in general practice municipal trading should be discouraged, but he preferred to argue the question on the basis laid down by legislature. They might object to the electric light undertaking because the Gas Company were ratepayers. But who would argue that a local authority should not compete with a Gas Company? He should be very much surprised if the Local Government Board objected to a local authority exercising its Parliamentary powers. So much for the question of principle. They could, if they chose, meet the whole capital expenditure out of the rates and not go to the Local Government Board at all. But they rightly considered that the expenditure should be spread over a reasonable period. This inquiry was not into the establishment of the undertaking, but of one already established. They started with a loan of £10,000, because they thought it would be enough. It was too ridiculous to make the success of the undertaking a reason for choking it. He was accused of using unfair argument in saying if the loan was not granted it would come out of the rates, but he did not mention that as a reason for the Local Government Board granting the loan. He recognised that that would be improper. What he said was that their undertaking was such a success that they could not wait for the sanction of the Local Government Board. It was not the fault of the department, but they made application to the Board in April (when at a moment down went the National charges), the inquiry was held in May, and the exchange was opened in July. Though they were commended by Mr. Hanbury for having done the right thing, they did not get the Board's sanction till November. That was where people made a great mistake in saying they ought to wait for sanction. The consent was only necessary to the loan. He agreed that under ordinary circumstances it would be improper to spend the money and then go to the Local Government Board, but municipalities could not wait and let the National Company cut the ground from under their feet. As to reducing rates, which side had commenced it? The National charged £8, the Corporation £5 17s 6d, and then the National charged £4; but, notwithstanding this, the residents preferred to pay the extra £1 17s. 6d. They were not unpatriotic. They had established their undertaking, and they intended to support it. He wished next to refer to the two objections taken to the scheme —one engineering and one financial. He submitted that Mr. Bennett, with one exception, had not been shaken in his evidence. Every possible attack had been heaped on Mr. Bennett's head. It was suggested that he was actuated by the commission he earnt. If Sir Wm. Preece had been giving evidence on electric lighting, would that suggestion be made against Sir Wm. Preece? It was no shame to Mr. Bennett or to Sir Wm. Preece that they were paid commission. He hoped he had made it clear that the income he quoted was not actual receipts. He could not give a year's experience when they had not been working a year. He need not have submitted any estimate of income at all, because they had got their powers. The borough accountant had averaged the probable receipts, and although it was suggested they would have withdrawals, that had not been their experience so far. At the end of the year they hoped to have 315 more revenue-earning lines. There could not be a case in which a telephone authority could put before them such a favourable statement on such a short experience. Evidence had been called to attack both their engineering and finance. He listened carefully to the evidence of Mr. Snowdon, who paid that very cursory visit to Tunbridge Wells, but that was not evidence on which this installation could be condemned. Mr. Snowdon, who spent a few hours here, asked them to believe that £19,000 worth of installation was not of a character that the Local Government Board ought to approve. That would be the only object of that evidence, viz., that this was such a defective installation that a loan ought not to be granted upon it. The defects which Mr. Snowdon found were trumpery. They all knew what contractors were. Their department had been so busy that it had been driven off its legs with work. Some little faults existed, but it was childish to suggest that the installation was inefficient. Then Mr. Kingsbury had frankly admitted that he had never established a telephone system, and had no experience of its working.

Mr. Kingsbury: May I say I never stated that. I have had experience of the whole run of exchanges. I have established several businesses.

The Inspector: It is quite fair that should be corrected. I think he gave very fair evidence.

Mr. Cripps: I accept Mr. Kingsbury's correction.

Mr. Cripps viewed with grave suspicion the evidence of a man the National Telephone Company dealt with. Mr. Kingsbury supplies goods from abroad. Mr. Bennett was attacked for doing this.

The Inspector: Do not make the mistake you suggest was made as to Mr. Bennett.

Mr. Cripps said he did not want to, but Mr. Kingsbury's evidence must be for the benefit of his customers. His friend said that spares was the crux of the question. He agreed, because they had been crucified with spares.

The Inspector: Two questions were the crux, depreciation and spares.

Mr. Cripps said he would deal with the question of spares. The opposition contended that there should be 25 per cent. of spares, but Mr. Bennett was not responsible for the fact that the spares had been used up. If necessary, they would not shrink from the expenditure required to meet any demands upon them, which they had no spare lines left for.

Mr. Drury: I am afraid Mr. Cripps is missing the point

The Inspector: I am afraid you have not much time to explain it.

Mr. Drury: It is not a question of saving Mr. Bennett's estimates, but a financial question.

Mr. Cripps said he endeavoured to put the question clearly. He had to do his duty to the Corporation. Ribald laughter was no argument.

Mr. Robb: Except by yourself.

Mr. Cripps said his friends shifted their ground. Mr. Bennett had not said the spares would not be necessary. He was asked what they would do as they increased their business. They would have to come for a further loan. It was said that their account showed nothing for depreciation, but he suggested that the profit they claimed to show would be ample for depreciation. £1,086 was more than ample. It was not contemplated that municipalities should make a profit in relief of the rates, but as a contingency fund. In such an undertaking a depreciation fund was

unnecessary. What was the position at the end of 25 years? The loan would be repaid? The undertaking might be only scrap iron value. Their license would be at an end, and they had a purchaser for such of the plant as was efficient. The ratepayers would have lost nothing. What did it matter to them whether the plant depreciated or not. It did not matter to the present generation how much or how little the plant was worth at the end of the license. The Inspector had suggested new inventions and other modifications of their plant, but they had the fact that the largest part of the capital was in cables which lasted, Mr. Bennett told them, almost for ever.

The Inspector: The witness knew we shall not live to verify it.

Mr. Cripps said they were asked how a poor little municipality could fight against a big company, but he submitted that the National Company did not provide a large fund. As they were the only municipal exchange, he had only the example of the National Company to fall back upon. In conclusion, he thanked the Inspector, and if they had trespassed on his indulgence they regretted it. He could not close without an appeal on behalf of the Corporation, who were performing an onerous duty. They asked one department of the Government for the means to carry out a duty placed on them by another Government department, and they could not conceive that this loan would not be granted, and put in the position of telling people they could not extend their exchange, because some ratepayers objected to it. He felt strongly that if a Government department took such a course, the sooner the Telegraph Act was repealed the better, because the municipalities would have been greatly misled in this undertaking. They had been told by Mr. Hanbury that the municipalities of Glasgow and Tunbridge Wells had come to the rescue of the Government; they were urged by the Treasury and the Post Office to make application for this license—he could show the Inspector the correspondence. They had started the Exchange, no one could say it had not been a triumphal success. If this loan were refused no greater slap in the face could have been given to the municipalities of this country. The action of the opposition could have but one result if successful, viz., to benefit a monopoly, and place a heavy charge on the rates, and when the cutting rate answered its purpose the time would come when up would go the National rates, and they would be relegated to their old position of high telephone charges. He claimed that Tunbridge Wells deserved well of the country, and did not deserve the slight which the Local Government Board was invited to administer to it.

The Inspector: That terminates the Inquiry.

THE INFLUENCE OF TARIFFS ON ELECTRICITY SUPPLY.

By C. ASHMORE BAKER.

(*Concluded from page* 459.)

The most important figures which these systems of charging may be supposed to influence are the load factor, the rate of increase of lamps connected, and the ratio of price obtained to cost per unit; these figures have also been culled from the *Electrical Times* list and placed opposite their respective undertakings.

Taking the average values obtained for the above quantities from Table I. as a whole, we may place them for easier reference as in Table II.

TABLE II.

	Load factor.	Year's lamp connection increase per cent.	Price. Cost.
Flat rate	11·75	26	1·88
Maximum demand ...	11·14	38·68	1·768
Sliding scale	12·19	23·79	1·852

It will be, no doubt, somewhat of a surprise to many to discover from an examination of this table that the maximum demand system, which is usually adopted with a view to improving the load factor, appears to have, if anything, the opposite effect; the probability is, however, that in the large majority of cases it has no influence at all on this phenomenon.

The difficulty of explaining the system to consumers is well known, and it is probable that the average householder merely regards "that thermometer thing in the scullery" as a suspicious device on the part of the electricity people, designed to induce him to burn more units, and contents himself with lighting his lamps when he wants them, "maugre" his load factor, as he would if charged on a flat rate, and denies himself the luxury of consuming twopenny units merely because they *are* twopenny units (of which assertion he has serious doubts).

Looking at the figures relating to the rate of increase in the number of lamps connected, it will be observed that there is a marked difference in favour of the maximum demand system over the other two. It would, therefore, appear that the alluring prospect of those twopenny units is a powerful weapon in the hands of the canvasser, and an effective bait to the prospective customer, even though it may not convert that customer into a profitable consumer.

Turning to the financial column, defeat again rests with the maximum demand system, which, in view of the fact that the load factor is not improved by it while the price charged for a large proportion of the output is materially reduced, is a result which was only to be expected, particularly when it is considered how commonly the maximum demand system is misused by fixing the initial rate too low and providing separately for power consumers.

Comparing the sliding scale figures with those obtained for the flat rate system, it will be remarked that the load factor of the former stands appreciably higher than that of the latter, while the rate of increase of lamps connected is lower, a result probably due to such systems as the Hopkinson and that in use at Hastings, which the consumer is better able to understand, and, therefore, knowing that his actual consumption is charged for at a low rate, permits himself a more prodigal use of current, although the lump sum per lamp in which he is mulcted induces him to wire his house for as few lamps as possible. As the sliding scale systems are more or less heterogeneous, and number in Table I. only some 15 in all, it is perhaps not safe to place too great a reliance on the results they produce, which remark applies particularly to the average profit which, in the two classes, is so nearly the same as to render them practically identical for the purposes of the present paper.

It may be objected that the indiscriminate lumping together of a number of miscellaneous cases will render the results obtained untrustworthy; that companies cannot be compared with local authorities, or London districts with provincial ones. In order to meet these objections, we may examine the sub-divisions of Table I. separately, constructing for the facilitation of this purpose Table III. This on examination shows results not materially different from those exhibited in Table II.; for the sake of rendering inspection more easy the most favourable figures are printed in leaded type and the least so in italics.

Taking this table class by class, we find that in one case only (that of provincial companies supplying public lamps) is the load factor highest in the case of the maximum demand system; of the remaining five classes in which all three systems are represented, three fall to the flat rates and two to the sliding scales. It may be objected that the great London local authorities have been excluded from this comparison; unfortunately they have no near relations from a statistical point of view, their nearest neighbours in this respect being the great London companies having public lighting contracts, these battening as many of them do upon clubs, theatres, and such like haunts of vice, are able to scrape up an average load factor of nearly 15 per cent. between the two classes represented by them. If the London authorities are placed in the vacant space between these two sets of figures, it will be found that the load factor is again in favour of the flat rate system.

Considered generally, the most important class in Tables I. and III. is that representing the provincial local authorities supplying their own public lamps, of which there are 20 in the flat rate division and 31 employing maximum demand meters.

It may surely be assumed with safety that these numbers are sufficiently great to give at least an indication of the merits of the respective systems of charging represented by them. The figures stand thus:—

	Load factor.	Increase per cent.	Price. Cost.
Flat rate	12·57	25·2	1·92
Maximum demand ...	11·78	36·3	1·79
Sliding scale	11·85	29·13	1·802

That is to say (with regard to the first two classes) they are in the same order as in Table II., the differences being even more marked in the first and last columns, thus giving considerable support to the conclusions derivable from that table.

The remaining classes of undertakings, though the number represented in each is, as a rule, too small to render them reliable gauges of the values of the tariff systems they represent, still give general support to the results already

arrived at, and which point to the facts that maximum demand meters are useless for increasing the load factors of undertakings, though they may be of assistance in increasing the number of lamps connected.

Sliding scale systems, while improving the load factor, tend to keep down the total load, while the flat rate has apparently hitherto proved itself the best all-round system. It may be pointed out that it has not been an easy matter to decide in every case under what heading any particular undertaking should be placed; the published statements as to the method of charging employed are in many cases vague and undefined; the writer would submit, however, that an occasional discrepancy would not greatly affect the general results shown.

The general moral pointed by the foregoing would seem to be that the flat rate system is the only one at present in general use which may be considered satisfactory all round to both consumer and producer. There remains the fact, however, that that valuable bye-product, the day load, is still a glut in the market, and that if a sale is to be found for cheap electricity out of peak hours a method of charging must be adopted which will enable the consumer not only to ascertain by estimation in advance or direct inspection the amount of his liability, but will, as in the little tried Kapp system, enable him to know when and at what rate the cheap supply obtains. If means such as these are adopted and rationally applied, there can be little doubt that (in spite of the assertion of an astute observer that a man will not burn his lamps in the daytime, because he can do so cheaply), a day rate of definite amount sufficiently low, measured in a manner which the consumer is able to understand, and by which he is able at any time to ascertain the amount of his bill to date, will be likely to induce him to avail himself of that cheap supply for numerous small domestic conveniences, such, for instance, as heating, cooking, small motive power, &c., the employment of which is at present almost out of the question.

P.S.—Since the above was written, I have observed that Mr. Mordey has treated the subject in a somewhat similar manner in a contribution to the discussion on Mr. Wright's Institution paper. It is said that "great minds always think alike," I, therefore, take this opportunity of offering my congratulations to Mr. Mordey!

TABLE III.

	Flat rates.			Maximum demand.			Sliding scale.		
	Load factor.	Year's lamp increase per cent.	Price. Cost.	Load factor.	Year's lamp increase per cent.	Price. Cost.	Load factor.	Year's lamp increase per cent.	Price. Cost.
London companies	10·98	41·6	1·99	*10·29*	44·16	*1·68*	13·95	*14·5*	1·855
Do., with public lighting ..	15·67	17·7	1·66	—	—	—	*14·2*	*15·6*	1·886
Provincial companies ..	10·28	28·95	*1·166*	*8·5*	33·4	1·685	8·68	*22·8*	1·86
Do., with public lighting ..	*9·115*	*20·05*	1·86	10·97	46·3	*1·795*	10·915	25·4	1·945
London authorities	—	—	—	—	—	—	—	—	—
Do., with public lighting ..	—	—	—	14·83	50·04	*1·63*	—	—	—
Provincial authorities ..	10·58	30·6	2·48	*9·215*	31·6	1·94	12·86	*24·7*	*1·88*
Do., with public lighting ..	12·57	*25·2*	1·92	*11·78*	36·3	*1·79*	11·85	29·13	1·802

CENTRAL STATION LOSSES.

By AN ASSOC. M.INST.C.E.

The continued struggle amongst central station engineers to generate and sell electrical energy at a very low cost has produced some remarkable results in the annual cost sheets of certain undertakings.

Reduced costs are usually brought about by a combination of the undermentioned factors:—

1. New plant.
2. Skilled supervision.

With regard to the former item, this, of course, means capital expenditure, which, although justified in most instances, in many others means that the engineer of the concern has admitted his inability to handle his plant so as to make it a remunerative investment to the owners.

In our opinion, however, skilled supervision is destined to play a much more important *rôle* in the future than many of us are disposed to admit.

Let us turn for a moment to the boilers. How many engineers are in a position to say upon scientific authority that they are getting the fullest practical thermal value out of their fuel?

In one central station which we have in mind, the coal bill has been reduced to the extent of several thousand pounds a year by adopting the simple expedient of burning the ashes, which were produced to an abnormal extent by an inefficient, though much-used, type of patent mechanical stoker.

The brickwork setting of water-tube boilers, such as the Babcock & Wilcox type, requires most careful erection. As little fire-clay as possible between the layers of bricks should be used, and even then the air leakage in most instances becomes excessive in the course of a year or two, and the efficiency of the boiler rapidly falls. So serious is this drop, and so difficult is it to prevent air leakage, that the final cure seems to resolve itself into entirely casing the boiler, or battery of boilers, with thin sheet-iron.

This remedy is so complete that the additional initial outlay is amply justified by the results obtained.

No doubt when the demand for casing water-tube boilers with sheet-iron becomes more general, the manufacturers will be able to reduce the somewhat heavy initial outlay at present necessary in its adoption.

Probably the next source of boiler inefficiency in order of importance is that due to inferior stoking. Partially uncovered fire-bars can usually be discovered in any battery of working boilers, especially where mechanical stokers are used.

The excess of air supply over and above that required for perfect combustion will here readily reveal itself in the scanty percentage of CO_2 amongst the flue gases, together with a low temperature.

It is difficult to realise the enormous loss of fuel due to banking fires as stand-bys without making careful tests. We have noticed on more than one occasion that one battery of boilers has consumed considerably more coal than another precisely similar battery when banked and shut off the steam mains.

The explanation of this apparent anomaly can usually be very easily stated in the words "leaky dampers." This is a most fruitful source of loss, and one to which too much attention cannot be given. Again, steam mains are frequently charged with steam, and left to radiate their heat at times of light load, when a little forethought might easily have obviated the expenditure. And, finally, having enumerated a few of the usual sources of loss in boiler efficiency, it can be seen that most of the waste involved could be very much reduced, or altogether eliminated, by skilful supervision.

Passing into the engine house, the problem of economical running of existing plant does not leave very great scope for the useful resources of the engineer.

¶ A good load factor on the running generators is, of course, essential, and no spares should be run except in cases of great necessity, so that here, again, we see the human factor playing a prominent part.

This difficulty is, of course, very much increased where alternators are run in parallel, especially where the frequency is very high, owing to the phasing trouble, which may be said to increase in direct proportion to the number of cycles per second of the generators.

With regard to condensing with surface condensers, perhaps the greatest scope here presents itself to the ingenuity of the engineer, though it is only fair to say that it is not possible to economise much of the heat with the existing arrangements of most central stations.

It is well to remember that if the heat which is rejected by us with the circulating water discharge can be utilised for work, the efficiency of the steam engine rises to a remarkable degree.

The sulphur dioxide engine, of which a full description has appeared in the REVIEW, is a pleasing exemplification of the new method. We do not for a moment claim the discovery of a scientific principle, but we certainly think that the principle might be turned to advantage in a much wider application than at present.

Many of us make every effort to keep the whole of our steam plant condensing, when it is evident that we should secure a great deal of the latent heat of the steam now being turned to waste for raising the temperature of the feed-water. Sometimes the exhaust steam from the auxiliary engines (steam pumps, exciters, &c.) can be diverted to this purpose, though the practice is not to be recommended as the best, for we must remember that auxiliary engines, to a much greater extent than motors, involve considerable expense for repairs and maintenance, for attendance, and for stores. It therefore seems evident to us that the most economical process is to run a considerable proportion of the auxiliary plant by motors, and to heat the feed-water with some of the otherwise wasted latent heat from the main engines by turning some of the exhaust steam into it.

This method should involve very little expenditure in capital outlay, especially as it is not advisable, for obvious reasons, to convert more than a certain percentage of the auxiliary steam plant to the motor-driven system.

In pointing out a few of the items which should demand special attention in the effort to reduce works costs, we have not alluded at any length to labour economy, as this is so much regulated by circumstances, very many of which are beyond our control. Oil is generally the heaviest item amongst engine-room stores, and we are aware of several instances in England where a reduction of 60 per cent. in its consumption has been secured by scientific investigation combined with skilled supervision.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1902.

Compiled expressly for this Journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London W.C., and at Liverpool, to whom all inquiries should be addressed.

ERRATUM.—For No. 5,535 in our last issue, read 5,536.

5,670. "Improvements in automatic apparatus for controlling and operating the points of electrical railways and tramways." J. B. STEWART, W. H. TURNER, and R. E. DIXON. March 7th.

5,831. "Improvements in systems and apparatus for regulating electric currents." R. C. CLINKER. March 10th.

5,851. "Improvements in prepayment gas or other fluid or electricity supply controlling apparatus." H. COONEY. March 10th. (Complete.)

5,862. "Improvements in rheostats." J. LUNDIE. (Date applied for under Patents Act, 1901, August 15th, 1901, being date of application in United States.) March 10th. (Complete.)

5,888. "Improvements in magneto-electric therapeutic appliances." L. S. OSMAN. March 10th.

5,891. "Improvements in electrical watt-meters." V. A. ARCIONI. March 10th.

5,897. "A new or improved electric circuit interrupter." J. W. T. CADETT and E. S. SHEPHERD. March 10th.

5,913. "Improvements in thermo-electric material." H. BRAMER. March 11th. (Complete.)

1,934. "A new and improved combination clock, electric battery and lamp, with self-contained case for the same." H. WATERSON. March 11th.

5,944. "Improved telegraph systems." W. L. WISE. (J. H. Pierce, United States.) March 11th. (Complete.)

5,952. "Improvements in and relating to electric arc lamps." W. P. THOMPSON. (E. Sander, Germany.) March 11th.

5,960. "Fuse box for electric currents." W. C. HUNNIBALL and G. CARR. March 11th.

5,972. "Electrical arrangement for enabling sounding signals to be exchanged between locomotives in motion, and the stations, stopping places, &c., and between the locomotives for the purpose of preventing railway collisions." E. DANNEELS. March 11th. (Complete.)

5,978. "Improvements relating to rectifiers for single or polyphase alternating currents." A. NODON. March 11th.

5,981. "Improvements in rail bonds or connections for electric railways." G. B. BLANCHARD. March 11th.

5,988. "An automatic electrical cut-out." D. R. BRUCE. March 11th.

5,997. "Improvements relating to the controlling of electric circuits." S. Z. DE FERRANTI. March 11th.

6,000. "Improvements in apparatus for producing high electrical potentials, and in means for utilising the same for the ignition of explosive mixtures or compounds in explosion motors." E. EISEMANN. March 11th. (Complete.)

6,009. "Improved fire alarm telegraph repeater apparatus." L. G. WOOLLEY. March 11th. (Complete.)

6,024. "Improvements in or relating to electric arc lamps." C. OLIVER. March 11th.

6,093. "Improvements in apparatus for testing electrical circuits." J. E. PRESTON and S. S. ALCOCK. March 12th.

6,121. "Improvements in electric arc lamps." J. J. RATHBONE. March 12th.

6,122. "Improvements in electric switches or circuit closers and breakers." OTIS ELEVATOR COMPANY, LIMITED. (Otis Elevator Company, Incorporated, United States.) March 12th.

6,143. "Improvements in automatic regulation of voltage in alternating electric current systems." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, and H. S. MEYER. March 12th.

6,147. "Improvements in portable hand-combination telephones." A. ECKSTEIN and A. BROOKER. March 13th.

6,148. "An improved thermostatic cut-out for electric heating circuits." A. ECKSTEIN and C. H. ARCHER. March 13th.

6,155. "An improved device for cleaning overhead electrical conductors." E. M. HOLLINGWORTH. March 13th.

6,184. "Improvements in section insulators for electric trolley conductors." H. HIRST and W. WOOD. March 13th. (Complete.)

6,193. "An apparatus for the measurement of high electrical resistances." O. COX. March 13th.

6,209. "Improvements in or relating to electric arc lamps." S. H. JOHNSON. March 13th. (Complete.)

6,233. "Improvements in and relating to automatic electric circuit breakers." S. Z. DE FERRANTI, C. C. GARRARD and H. W. CLOTHIER. March 13th.

6,295. "Improvements in or relating to brakes for electric tramcars and like vehicles." G. A. TRUBE and W. CHAPMAN. March 14th.

6,304. "Improvements in and relating to the manufacture of electric accumulator plates." ACCUMULATOR INDUSTRIES, LIMITED, and J. J. H. HUNTE. March 14th.

6,328. "Improvements in electricity meters." W. M. MORDEY and G. C. FRICKER. March 14th.

6,331. "Improved electrical cooking apparatus." M. BAYNO. March 14th. (Complete.)

6,345. "Improvements in electric light signals." W. TABOULEWITSCH. March 14th. (Complete.)

6,346. "Improvements in and relating to electro-magnetic circuit-breakers or cut-outs." E. L. JOSEPH and G. HARDNER. March 14th. (Complete.)

6,347. "Improvements connected with electric railways." J. SWINBURNE. March 15th.

6,376. "Improvements in and relating to arc lamps." W. PATERSON. March 15th.

6,379. "A continuous burning arc lamp with inclined carbons." J. A. RIGNON and E. EISEMANN. March 15th. (Complete.)

6,383. "Automatic electric battery regulating switch." J. E. SPAGNOLETTI and J. LAWRENCE. March 15th.

6,396. "Magnetic contact box for electric tramways." B. J. B. MILLS. (A. Diatto, Italy.) March 15th.

6,430. "A new or improved system of overhead construction for electric railways." E. H. TYLER. March 15th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1900.

3,683. "Improvements in electricity meters." M. E. Reason, W. Paddison, H. C. Hughes (executors of H. Reason), and Reason Manufacturing Company. Dated February 24th, 1900. The field magnet of a motor meter has a divided magnetic circuit, one branch consisting of steel or permanent magnets, while the other branch is an air space, the steel being magnetically saturated, so that it does not carry the entire flux. In the form described, soft iron pole-pieces and a magnetising coil are carried by plates, which are connected at the corners by steel bolts. 2 claims.

3,731. "Improvements in the manufacture of electrically conducting material." E. Sander. Dated February 26th, 1900. Electrically conducting material is made by mixing two or more finely-divided substances selected from both of two classes, in equal or other proportions, and fusing the mixture in an electric or other furnace. 4 claims.

3,753. "Improvements in and relating to electrical secondary batteries." E. N. Commelin and R. A. Viau. Dated February 26th, 1900. The positive electrode is made up of two grids of insulating material, which enclose between them a number of lead strips, which are attached to, or form part of, a connecting strip. The framework thus formed is filled with lead peroxide. The negative electrode is made up of a number of superposed troughs of insulating material, fitted in a frame. Each trough contains a wire, strip, or sheet of lead or other material connected to a conductor, which is embedded in the insulating frame. The electrolyte employed is a solution of cadmium sulphate, so that, during "forming," cadmium is deposited on the strips. 5 claims.

3,762. "The application of steatite to electrical purposes as an insulating material." F. de Mare and E. Fremy. Dated February 27th, 1900. Relates to the preparation of steatite as an insulating material, and its application to igniters for gas, &c., engines. 2 claims.

"ELECTRICAL REVIEW" LIST OF ELECTRICITY S

Place.	Supply Authority.	Year of opening	Engineer.	Pressure of supply, volts.	Frequency and phase.	Boilers and auxiliaries.	Engines.	Generators.	Capacity in KW.	Max. load recorded in KW
PROVINCIAL.										
1 **ABERDEEN**	Corporation	1894	J. Alex. Bell	220 & 440	Direct	8 B. & W., 2 suphtrs., Worth'n pps. (Cotton St.). 6 B. & W., suphtrs., ch. g. stokers, Weir pps., surf. cond., Edwards air pps. (Dee Village).	9 Willans, 1 Belliss 4 Willans, all vert. comp.	5 E.C.C.; 2 Holmes; 1 Crompton; 1 Peebles; 1 Mather & Platt. 1 J. Lundell; 2 Mavor & Coulson; 1 Westinghouse.	1,200 1,240	1,205
2 **ABERYSTWYTH**	A. & Chiswick Elec. S. Corpn., Ltd.	1835	E. E. Putland	100 & 220	100~, 1-ph., & direct.	3 Paxman Economic	4 Browett-Lindley, vert. comp., 2 Peache.	2 Johnson & Phillips, A. C., 2 J. & P. D. C., 2 Brush arc.	240	124
3 **ACCRINGTON**	Corporation	1900	H. Gray	230	Direct	2 Lanc., econ., jet cond.; Horsfall destr.	3 Willans, 2 Browett-Lindley	3 J. & P., 2 Lancs. Dyn. Co.	530	240
4 **ALDERLEY EDGE**	A. & Wilmslow El. Supply Co. Ltd.	1899	C. W. Bentley	210	Direct	2 loco. (Paxman)	2 Belliss, vert.	2 Edison-Swan	92	43
5 **ALDERSHOT**	Urban District Council	1902	O. F. Francis	210 & 420	Direct	2 B. & W., econ, surf. cond.	3 Willans	3 Parker	270	..
6 **ALLOA**	Corporation	1902	A. Yuill	220 & 240	Direct	..	..	..	..	..
7 **ALNWICK**	Nthn. Cties. Elec. Supply Co., Ltd.	1902	C.S. Vesey Brown C.W. Fairweather	230 & 460	Direct	2 B. & W., stokers and econ.	2 Ruston Proctor	2 Crompton	150	..
8 **ALTRINCHAM**	A. Elec. Supply Co., Ltd.	1895	H. C. Caldwell	100	80~, 1-ph.	6 Lanc. (4 Meldrum furn., 2 w. stokers), ejector cond., and econ.	5 Browett-Lindley, vert. comp.	5 Edison & Swan	600	399
9 **ASHTON-U-LYNE**	Corporation	1899	N. Appelbee	240 & 480	Direct	4 Lanc., 2 tubular, econ., surf. cond.	3 Browett-Lindley, 2 Belliss, all vert. comp.	3 Jackson (Sayers), 3 Siemens	1,260	700
10 **AYR**	Corporation	1896	A. J. Fuller	200 & 250	60~, 1-ph. and direct.	4 Lanc., 2 Stirling, Vicars and chain grate stokers.	8 Belliss vert., 1 Marshall hor.	4 Siemens A.C.; 1 Siemens, 2 Peebles, D.C.	1,150	410
11 **BANCOR (WALES)**	Corporation	1900	P. F. White	200 & 400	Direct	2 Hornsby, w. t., Meldrum destr.	3 Willans	2 Fowler, 1 J. P. Hall	270	140
12 **BARKING**	Urban District Council	1899	A. H. Seabrook	230 & 460	Direct	4 B. & W., motor pumps and cond., clg. tr.	3 S. Forge, 3 Allen, all vert. comp.	4 S. Forge, 2 Thames Ironworks, 1 Siemens.	650	204
13 **BARNES**	Urban District Council	1901	C. S. Davidson	210 & 420	Direct	3 B. & W., surf. cond., fd. htr.	4 Belliss (2 triple, 2 comp.).	4 Siemens	470	60
14 **BARNSLEY**	Corporation	1900	S. E. Bastow	230	Direct	5 Lanc., stokers, surf. cond., econ.	5 Willans	4 J. & P., 1 Peebles	675	..
15 **BARROW-IN-FURNESS**	Corporation	1899	H. R. Burnett	220	Direct	4 B. & W., econ., surf. cond.	3 Universal, 2 Willans	3 Brush, 2 Peebles	525	271
16 **BATH**	Corporation	1890	F. Teague	100 & 200	100~, 1-ph.	4 B. & W.	2 Pollitt & Wigzell, 4 Brush (marine), all vert. comp.	2 E.C.C., 4 Mordey (rope-driven)	1,000	634
17 **BECKENHAM**	Urban District Council	1900	A. J. Hedgcock	200 & 400	50~, 1-ph.	4 B. & W., econ., heater detartariser	3 Belliss	3 Fowler	300	187·5
18 **BEDFORD**	Corporation	1894	R. W. L. Phillips	100 & 200	60~, 1-ph.	7 B. & W., 2 Lanc., stokers, surf. cond.	2 Belliss, vert. comp., 5 Allen	1 Johnson & Phillips, 2 Siemens, 3 Fynn	860	580
19 **BELFAST**	Corporation	1895	V. A. H. McCowen	220 & 440	Direct	6 Lanc., 4 B. & W., stokers, econ., feed htrs., surf. cond., clg. tr.	Belliss, 8 vert. comp., 2 vert. triple	6 Parker, 5 M. & P., 1 J. & P.	3,000	1,485
20 **BEXHILL-ON-SEA**	Corporation	1900	W. T. Le Feuvre	220 & 440	Direct	2 Hornsby, 1 B. & W., suphtrs., surf. cond. clg. tr.	3 Allen vert. comp.	3 Allen	350	250
21 **BIRKENHEAD**	Corporation	1896	W. Bates	230	Direct	3 Lanc., Vicars stokers, econ.	7 Willans	3 Crompton, 2 Siemens, 2 Mavor & Coulson:	900	384
22 **BIRMINGHAM**	Corporation	1891	J. C. Vaudrey	220 & 440	Direct	20 Lanc. 4 B. & W.	13 Willans, 9 Belliss	4 M. & P., 13 Crompton, 5 E. C. C.	4,400	3,200
23 **BLACKBURN**	Corporation	1895	A. S. Giles	110, 220, & 440	50~, 1-ph., & direct	8 Lanc., stokers, econ., part surf. cond.	5 Willans, 7 Belliss	1 M. & P., 7 Siemens, 3 Mavor & Coulson, 1 E. C. C.	2,300	1,406
24 **BLACKPOOL**	Corporation	1893	C. Furness	200	83~, 1-ph., & direct	5 Lanc., 2 Marine, 5 B. & W.	5 Fowler hor. comp. (ropes), 1 Ferranti vert. comp., 8 Parsons	5 Leeds & London, 1 Ferranti, 8 Parsons (turbines).	3,550	1,460
25 **BOLTON**	Corporation	1894	A. A. Day	100&200 a.c.; 230&460 d.c.	83~, 1-ph. & direct.	13 Lanc., stokers, suphtrs., jet cond., clg. tr., econ.	4 Musgrave, cond., 4 Hick-Hargreaves, non-cond., 1 Wood (rope gr.), all vert. comp.	4 Mather & Platt D.C.; 4 Ferranti, 1 Mordey, A.C.	5,000	2,000
26 **BOOTLE**	Corporation	1899	T. D. Clothier	220 & 440	Direct	4 Lanc., stokers, econ., ejector cond.	6 Belliss, vertical	5 Parker, 1 E.C.C.	1,250	615
27 **BOURNEMOUTH**	B. and Poole Electy. Supply Co., Ltd.	1891	E. L. Ingram	100 & 200	100~, 1-ph.	11 B. & W., cond., cooler, suphtrs.	11 Brush, vert. comp.	9 Mordey A.C., 2 Brush D.C.	1,930	1,027
28 **BRADFORD**	Corporation	1889	R. A. Chattock	230 & 460	Direct	4 Lanc., 6 marine, ind. draught stokers, 6 water-tube, econ.	18 Willans, 1 Marshall	15 Siemens, 2 E.C.C., 2 Peebles	4,380	3,593
29 **BRAY**	Urban District Council	1892	A. E. Wilkins	100	60~, 1-ph.	1 Loco.; 1 Lanc., cond. econ.	1 Brush, 1 Robey, 1 Easton-Anderson, 2 Victor turbines.	1 Mordey, 2 Kapp, 1 International	195	95
30 **BRECHIN**	Angus E. L. & P. Co., Ltd.	1901	J. E. Edmundson	240	Direct	2 B. & W., suphtr., feed htr.	2 Belliss	2 Parker	132	36·5
31 **BRICHOUSE**	Corporation	1897	A. Aspinall	110	Direct	..	3 Crossley gas	3 Brook	40	..
32 **BRIGHTON**	Corporation	1891	J. Christie	115, 230 & 460	Direct	6 Lanc., 10 B. & W.	19 Willans	2 Goolden, 2 Siemens, 3 Crompton, 3 Peebles, 7 E.C.C.	5,935	3,718
33 **BRISTOL**	Corporation	1893	H. F. Proctor	105, 210, 250 & 500	93~, 1-ph. & direct	Temple Back:—12 Lanc., 2 B. & W., stokers, surf. cond. Avonbank:—4 B. & W., stokers, suphtrs., surf. cond.	18 Willans comp. 4 Willans triple	17 Siemens, 1 Ferranti 4 Siemens	3,102 2,170	2,535
34 **BROMLEY (KENT)**	Bromley (Kent) E. L. & P. Co.	1898	R. L. Gamlen	210	Direct	4 Paxman economic, surf. cond.	5 Belliss	5 Parker	600	300
35 **BUCKINGHAM**	B. Elec. Lt. & Pr. Supply Co.	1889	"	100	Direct	1 Cochrane marine vertical, 1 Marshall loco.	1 hor. Brown & May, 1 Marshall semi-port.	1 Greenwood & Batley, 2 Elwell-Parker, 1 Goolden	60	..
36 **BURNLEY**	Corporation	1893	R. Birkett	110, 220 & 440	Direct	5 Lanc., stokers and econ.	3 Burnley Iron Works hor. comp., 2 Bellis vert. comp.	5 E.C.C.	1,030	590
37 **BURTON-ON-TRENT**	Corporation	1894	F. L. Ramsden	100 & 200	75~, 1-ph.	6 Lanc., econ., ejector and jet cond.	3 Fowler hor., 1 Alley-Maclellan vertical.	3 Fowler, 1 Brown-Boveri	800	306
38 **BURY**	Corporation	1896	S. J. Watson	220 & 440	Direct	3 Lanc., econ. cond.	4 Belliss	4 Siemens	760	273
39 **BURY ST. EDMUNDS**	Corporation	1900	L. F. Greig	200 & 400	Direct	2 Lanc., detart., econ.	2 Belliss	2 Fowler	132	65
40 **BUXTON**	Urban District Council	1900	W. J. Leeming	230	Direct	6 Hornsby w.t., jet cond.	6 Belliss	6 M. & P., 2 Sunderland Forge, 1 E. C. C.	534	180
41 **CAMBRIDGE**	Cambridge Elec. Supply Co., Ltd.	1892	H. B. Harvey	100 & 200	900~, 1-ph.	4 Lanc. econ.	7 Parsons turbines	7 Parsons	1,700	508
42 **CANTERBURY**	Corporation	1899	C. A. Blascheck	220	Direct	4 Lancs., stokers, econ., ejector and surf. cond.	4 Belliss	6 Silvertown, 2 Johnson & Phillips	600	275
43 **CARDIFF**	Corporation	1894	A. Ellis	100 & 200	40~, 1-ph.	5 Dryback, 3 B. & W., suphtrs., jet and surf. cond.	2 Paxman triple, 2 Belliss comp., 1 Ferranti vert. comp.	4 Siemens, 1 Ferranti	1,340	951
44 **CARLISLE**	Corporation	1899	C. D. Burnet	230 & 460	Direct	5 Lanc., stokers, econ., jet cond.	6 Willans	2 Peebles, 6 Siemens	870	Ltg. 488.
45 **CARLOW**	J. Alexander	1890	G. M. Harriss	100 & 200	70~, 1-ph. and direct	1 B. & W.	1 Belliss; 2 Waverley, 1 Vortex, turbines (water).	2 E. C. C., A.C., 1 Laurence Scott, D.C.	115	..
46 **CHAGFORD**	C. & Devon E. L. Co., Ltd.	1891	G. H. Reed	100	99~, 1-ph.	..	Water-wheel	2 Siemens	22	19
47 **CHATHAM AND ROCHESTER**	C., R. & District E. L. Co., Ltd.	1888	C. T. Linney	100 & 200	100~, 1-ph.	1 Lanc., 3 B. & W., cond. clg. tr.	3 Marshall, 1 Robey, 1 Parsons	2 Mordey, 2 Ferranti, 1 Parsons	900	337
48 **CHELMSFORD**	C. Elec. Lighting Co., Ltd.	1890	A. H. French	100 & 200	100~, 1-ph. and direct	2 Lanc., 2 B.& W., stokers	6 Willans, 2 Peache	10 Crompton	605	349
49 **CHELTENHAM**	Corporation	1895	M. H. Kilgour	100 & 200	100~, 1-ph., & direct	1 Lanc., 6 B. & W., and econ	3 Willans, 4 Belliss, 2 Parsons turbines	5 Siemens (2 D.C., 3 A.C.), 2 Parsons A.C., 2 Witting Bros. D.C.	1,700	750
50 **CHESTER**	Corporation	1896	F. Thursfield	210	Direct	7 B. & W., stokers	6 Belliss	6 Parker	1,000	679
51 **CHESTERFIELD**	Corporation	1901	R. L. Acland	240 & 480	Direct	4 B. & W., econ.	3 Belliss	3 Westinghouse	400	217
52 **CHISLEHURST**	Chislehurst Elec. Supply Co.	1899	R. L. Gamlen	210	Direct	..	..	2 Parker motor transformers	80	50
53 **CHISWICK**	Aberystwith & C. Elec. Supply Corp., Ltd.	1901	A. W. Money	220 & 440	Direct	2 Economic, forced draught	3 Peache, vert. compound	3 Johnson & Phillips	498	206
54 **COATBRIDGE**	Scottish House-to-H. El. Co., Ltd.	1894	J. B. McIndoe	240	Direct	2 Lanc., stokers, surf. cond.	2 Browett-Lindley	2 Brush	300	..
55 **COLCHESTER**	Corporation	1898	A. R. Sillar	210	Direct	3 Economic, surf. cond.	5 Peache	5 Siemens	575	240
56 **COLNE**	Corporation	1901	A. G. Cooper	240	Direct	1 B. & W., 1 Lanc., stoker, suphtrs., econ., cond.	1 Parsons turbine, 1 Belliss	1 Parsons, 1 Greenwood & Batley	200	..
57 **COLWYN BAY**	Urban District Council	1898	A. R. Tudman	220 & 440	Direct	2 B. & W.	2 Browett-Lindley vert., 1 Stockport gas.	3 Bertram Thomas	195	98
58 **CORK**	C. Elec. Tramways and Lighting Co.	1898	H. H. Nalder	230 & 460	Direct	6 B. & W.	2 Allis, 3 McIntosh and Seymour, 1 Belliss.	6 B. T. H.	1,250	835
59 **COVENTRY**	Corporation	1895	J. A. Jeckell	200	87~, 1-ph.	4 Lanc., stokers, econ., jet cond.	3 Fowler, 1 Belliss	3 Fowler, 1 Fynn	550	387
60 **COWPEN & BLYTH**	Northern Counties Elec. Supply Co., Ltd.	1901	C. S. Vesey Brown, C.W. Fairweather	230 & 460	Direct	2 B. & W.	2 Allen	2 Crompton	400	..
61 **CREWE**	Corporation	1900	H. H. Denton	230 & 460	Direct	3 Lanc., stokers, econ., ejector cond.	3 Willans	3 Mather & Platt	550	235
62 **CROYDON**	Corporation	1896	T. H. Minshall	200	60~, 1-ph. & direct.	5 Paxman, 4 B. & W., 2 Danks multitub., 3 clg. trs., suphtrs., econ.	10 Belliss, vert., comp. & triple	7 B.T.H., A.C.; 3 B.T.H., 1 E.C.C., D.C.	3,215	1,564
63 **DARLINGTON**	Corporation	1900	J. R. P. Lunn	230 & 460	Direct	3 Lanc.	4 Scott & Mountain, 1 Allen	4 Scott & Mountain, 1 Parker	470	186
64 **DARTFORD**	Urban District Council	1901	A. J. C. Waterland.	230 & 460	Direct	2 Lanc., stokers, surf. cond.	2 Reavell compound	2 G. E. Co.	200	..
65 **DARWEN**	Corporation	1899	C. Garnett	230 & 460	Direct	2 Lanc., stokers, ejector cond., 2 Lanc. over destructor.	4 Belliss	2 Siemens, 1 Mather & Platt, 1 Peebles	950	540
66 **DERBY**	Corporation	1893	T. P. Wilmshurst	100 & 200	40 ~, 1-ph.	6 Lanc., 3 B. & W., econ.	3 Ferranti, 9 Browett-Lindley	3 Ferranti, 9 Siemens	2,300	950
67 **DEVONPORT**	Corporation	1901		230	Direct	5 B. & W., atmo. and surf. cond., feed htrs., econ.	1 Browett-Lindley, 3 Ferranti	4 E. C. C.	1,360	500
68 **DEWSBURY**	Corporation	1894	R. H. Campion	220 & 440	Direct	3 Lanc., econ.	6 Willans	4 Crompton, 2 Peebles	500	250
69 **DONCASTER**	Corporation	1900	W. Wyld	230 & 460	Direct	3 Lanc., stokers	6 Willans	5 Mather & Platt, 1 Peebles	688	154
70 **DOVER**	D. Electy. Supply Co., Ltd.	1895	L. W. Woodman	100	100~, 1-ph. and direct.	6 B. & W., econ., surf. and ejector cond.	Ltg., 5 Brush, pr. 2 Macintosh and Seymour, 1 Ball and Wood	5 Mordey, A.C., 3 G.E.C., D.C.	900	510
71 **DUBLIN**	Corporation	1892	M. Ruddle	200	83~, 1-ph.	4 B. & W.; 2 dry-back, feed htrs.	3 Victor Coates, 2 Fowler hor., 1 Willans, 3 Brush vert.	3 E.C.C., 2 Fowler, 1 B.T.H., 3 Brush arc.	900	720
72 **DUDLEY**	Corporation	1899	J. P. H. Marsh	230 & 460	Direct	6 B. & W., stokers, feed htrs., econ. and cond.	4 Westinghouse, 1 Ferranti	4 Westinghouse, 1 E.C.C.	1,000	..
73 **DUNDEE**	Corporation	1893	W. H. Tittensor	200	Direct	8 Lanc., atmo. and surf. cond., feed htrs., econ.	13 Willans	1 M. & P., 8 Siemens, 3 Parker, 1 Int. E. E. Co.	2,200	1,559
74 **DURHAM**	County of D. E. P. D. Co., Ltd.	1902	J. S. Frain	230 & 460	Direct	2 B. & W., suphtr. & jet cond.	2 Brush	2 Brush	200	75
75 **EALING**	Corporation	1895	J. Douglas Knight	100	40~, 1-ph.	6 Lanc., 4 stokers, cond.	11 Browett-Lindley, 3 Belliss, vert. comp.	Siemens, 9 A.C., 3 arc (1,800 v.)	1,130	555
76 **EASTBOURNE**	Corporation	1882	J. K. Brydges	200	50~, 1-ph.	2 Stirling, 2 Hornsby w.t., 2 Economic	2 Ferranti, 2 Willans, 1 Peache	2 Ferranti, 3 E.C.C.	1,200	515
77 **EAST HAM**	Urban District Council	1901	W. C. Ullmann	240	Direct	4 B. & W.	4 Musgrave horizontal	4 English Elec. Mfg. Co.	775	450
78 **ECCLES**	Corporation	1893	H. W. Angus	200	50~, 1-ph.	2 Lanc.	2 Browett-Lindley, vert., open, 1 ditto, enclosed	2 J. & P., 1 Rosling	280	135
79 **EDINBURCH**	Corporation	1895	F. A. Newington	230	50~, 1-ph., & direct	34 Marine, 4 Water Tube, with stokers	27 Willans, 4 Belliss	17 Siemens, 10 Mather & Platt, 4 Ferranti, 2 E.C.C.	10,477	6,007
80 **EPSOM**	Urban District Council	1902	H. F. Foster	230	Direct	2 Lanc., econ.	2 Alley & MacLellan tandem comp.	2 Laurence Scott	150	..
81 **EXETER**	Corporation	1889	H. D. Munro	100	100~, 1-ph.	5 B. & W., 1 suphtr., feed htrs.	3 Fowler, 1 Easton, 1 Brush, 1 Hick Hargreaves, 2 Alley	4 Mordey, 1 Fynn, 1 Ferranti, 2 Thomson-Houston arc.	670	412
82 **FAREHAM**	Urban District Council	1890	A. Blake	100	125~, 1-ph.	2 Loco., 1 Economic	1 Ransome hor., 2 Browett-Lindley, 1 Peache, vert., all comp. cond.	2 Thomson-Houston, 1 Johnson-Phillips, A.C.; 2 T. H. arc.	140	63
83 **FARNWORTH**	Urban District Council	1901	J. D. Pember	220 & 440	Direct	3 Lanc., econ. and cond.	3 Browett-Lindley	3 Lancashire Dynamo Co.	380	240
84 **FLEETWOOD**	F. & Dist. E. L. & P. Synd., Ltd.	1900	O. Hansom	200 & 400	Direct	2 B. & W., econ., destructor	2 Willans	2 Johnson-Phillips	120	96
85 **FOLKESTONE**	F. Elec. Supply Co., Ltd. (Edmund-	1898	T. Hesketh	210 & 420	Direct	4 Paxman Economic, surf. cond. (oil burnt in	6 Peache	6 Parker	1,100	434

COPYRIGHT.

TY SUPPLY WORKS OF THE UNITED KINGDOM.

	Capacity in KW.	Max. load recorded in KW.	Battery capacity and output.	Mains.	Total capital expended.	Private lighting, eqvt. 8 c.p. lamps.	Lamps added during year.	Public lighting.	No. and H.P. of motors.	Price charged per unit.	System of charging.	Remarks.	
n;	1,200	1,205	E.P.S., 20 KW. for 10 hrs. E.P.S., 90 KW. for 10 hrs.	Bare copper, bit. paper and jute in Crompton Davies casing, iron pipes, wdn. troughing, solid.	£114,503	70,449	12,382	163 arc., 261 inc.	165 = 597 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand.	Ltg. and traction, 58 car-motors = 1,440 H.P.	1
n;	1,240												
J.	240	124	.. ..	Armd. and lead covd. conc., B.I.W.	..	7,940	1,757	29 arc., 1 inc.	.. ..	6d.	Flat rate.	Public ltg. by contract	2
..	530	240	Chloride, 70 KW. for 5 hrs...	Single core ppr., feeders solid, dist. direct	£35,100	10,400	5,600	.. ..	9= 29 H.P.	Ltg. 5d. & 3d., pr. 4d. & 1½d.	Max. demand.	Destructor furnaces; coal used also	3
..	92	43	D-P., 240 KW. hrs.	Triple conc. fdrs., 3-core dist., both armd. and lead covd., Callender.	.. ..	4,081	2,982	.. ..	.. ..	7d. and 4d. ..	Max. demand.	Lighting only	4
..	270	..	300 amp-hrs.	Callender fdrs. and dist. laid solid	..	£20,000	..	8 arc.	..	Ltg. 6d. &. 4d., pr. 3d. & 2d.	Max. demand.	.. ..	5
..	..	..	.. ..	Fdrs. 3-core, dist. single, v. bit., Callender, solid ..	£9,500	2,800	..	20 arc.	3 = 2 H.P.	Ltg. 7d. & 3d., pr. 7d. & 2d.	Max. demand.	Supply in bulk from British Electric Plant Co.	6
..	150	..	Chloride 250 amp. hrs. ..	Callender, single, solid, in wood	£12,000	..	..	.. ..	.. ..	..	..	.. ..	7
..	600	399	.. ..	Fdrs. v.r. conc., dist. armd. dia. and ppr.	£59,192	38,676	4,442	.. ..	2= 15 H.P.	Ltg. 6d., pr. 3d. ..	Flat rate ..	.. ..	8
..	1,260	700	.. ..	Conc., paper and bitumen	£50,000	..	..	72 arc., 144 inc.	600 H.P.*	Under revision ..	Under revision	Ltg. and traction. Pr. for traction 1·5d. per unit. *Partly traction.	9
2	1,150	410	E. P. S., 30 KW. for 7 hrs. ..	A. C., conc. armd.; D. C., bit. solid. Callender ..	£65,000	22,000	4,200	116 arc, 150 inc.	2= 20 H.P.	Ltg. 5d.. pr. 2d. ..	.. ..	Lighting and traction	10
..	270	140	Chloride, 45 KW. for 6 hrs.	Ppr., lead covd., armd., B.I.W.	£20,000	6,200	700	.. ..	.. ..	Ltg. 5d., pr. 2½d...	Flat rate ..	.. ..	11
ss,	650	204	.. ..	Callender-Webber casing, solid, and 3-core	£30,000	10,000	2,000	17 arc., 450 inc.	10= 80 H.P.	Ltg. 4½d., pr 3½d.–1½d.	Ltg. flat rate, pr. sldg. sc.	Lighting and traction	12
..	470	60	E.P.S., 25 KW. for 7 hrs. ..	Jute, lead covd.; armd. direct, unarmd. in Sykes conduit, Callender.	£33,900	5,800	..	.. ..	.. ..	Ltg. 6d., pr. 3d. ..	Flat rate, dis.	.. ..	13
..	675	..	Pritchett & Gold, 50 KW. for 6 hrs.	Ppr., lead covd., solid, also armd. B.I.W.	£40,000	14,500	3,000	27 arc, 75 inc.	42= 153 H.P.	Ltg. 7d. & 2d., or 4½d. pr. 1½d.	Max. dem. & flat rate.	.. ..	14
..	525	271	Tudor, 30 KW. for 5 hrs. ..	Ppr. conc., B.I.W.	£51,306	21,143	6,088	22 arc.	41=175 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1½d.	Max. demand	High and low pressure, generating at 1,100 & 250 v.	15
..	1,000	634	.. ..	V. bit. single, solid, for h.p.; conc. fibre armd. for l.p.; Callender.	£95,000	32,207	7,951	177 arc.	.. ..	Ltg. 5d., ht. 2½d.	Flat rate ..	Supply by company 1899–7	16
..	300	187·5	.. ..	Conc., paper, lead covd., B.I.W. .. .. —	£50,000	17,000	11,000	17 arc, 32 inc.	4= 4 H.P.	Ltg. 6d., pr. 2d. ..	Flat rate ..	.. ..	17
as,	860	580	.. ..	V. r. in ducts, and ppr. B.I.W., 1, 2, and 3-core ..	£88,000	35,276	4,210	558 inc.	14 = 82 H.P.	Ltg. 5d½., pr. 3d.	Flat rate ..	.. ..	18
..	3,000	1,485	E.P.S., 90 KW. for 4 hrs ..	Single v. bit., solid, and drawn into c. i. and e. pipes	£174,000	96,500	23,000	60 inc.	180 = 810 H.P.	Ltg. 6d. & 2d., pr. 3d. & 1d.	Max.demand.	Station arranged for both lighting and traction.	19
..	350	250	Chloride, 50 KW. for 5 hrs. ..	Fdrs. triple conc.; dist. 3-core, paper, lead-covd, and armd.; B.I.W.	£33,000	11,500	9,000	41 arc, 332 inc.	9 = 26 H.P.	7d. and 3d.	Max.demand.	Further extension in hand	20
or	900	384	E.P.S., 60 KW. for 7 hrs. ..	Fdrs. lead covd., fibre, solid; dist. armd. lead covd., fibre, direct; Callender.	£66,454	28,591	6,375	54 arc.	15 = 39·5 H.P.	Ltg., 6d., 3d., 1½d., pr. 4d. 3d., 1½d.	Max.demand.	.. ..	21
C.	4,400	3,200	E. P. S...	Callender, solid	£543,657	173,000	22,000	..	290=800 H.P.	Ltg., 7d. & 4½d., pr. 4d. & 2d.	Sliding scale	.. ..	22
&	2,300	1,406	E. P. S., 100 KW. for 3 hrs...	V. r. on insrs. in c. i. conduits; v. r. conc. armd. in c. i. pipes, Siemens & Glover	£117,000	60,000	10,578	80 arc, 248 inc.	94=280 H.P.	Ltg. 6d. & 3d., pr. 2½d & 1½d.	Max. demand	Lighting and traction	23
ti,	3,550	1,460	Hart, 80 KW. for 5 hrs. ..	H.p. twin, l.p. conc. and single, paper, solid, B.I.W. and St. Helens.	£163,004	47,472	2,472	260 arc, 290 inc.	94*=2305 H.P.	Ltg. 7d. & 2d., pr. 2½d.	Max. demand	Lighting and traction .. .. .. * Includes traction.	24
ti,	5,000	2,000	.. ..	Conc., v. r., jute and ppr. lead covd. in pipes, and armd. direct and solid.	£151,006	84,451	..	10 arc, 6 inc.	54=300 H.P.	Ltg. 6d. & 3d. or 5d., pr. 5d. & 1d. or 2½d., tr. 1½d.	Max. demand & flat.	Lighting and traction, D. C. & A. C. Two 1,100 KW. sets erecting.	25
..	1,250	615	Chloride, 132 KW. for 6 hrs.	Ppr. lead covd. B. I. W., & v. bit., Callender, solid ..	£57,000	15,722	1,574	166 arc, 525 inc.	21=81½ H.P.	Ltg. 5d. & 3d., pr. 2d. to 1d.	Max. demand	Lighting and traction	26
..	1,930	1,027	.. ..	Armd. & unarmd., v.r., fibre and ppr. lead covd. ..	£195,828	66,022	12,583	.. ..	12 = 30 H.P.	Ltg. 7d. & 3½d., pr. 3d.	Max. demand	Lighting and traction, D. C. & A. C. ..	27
..	4,380	3,593*	E. P. S., 400 KW. for 6 hrs.	Ppr., lead covd., armd., also solid for fdrs.	£363,141	207,176	34,435	51 arc	754=3,400 H.P.	Ltg. 4½d., pr. 2d. & 1d., tr. 1d.	Flat rates ..	Ltg. & trac.; lamps free. Motors & arc lps. on hire. *Inc. traction 663 KW.	28
al	195	95	.. ..	Ppr. lead covd. conc. B.I.W., direct	£10,000	5,512	..	32 arc., 181 inc.	..	6d. & 3½d.	Max. demand & contract	.. ..	29
..	132	36·5	D. P. 300 amp.-hrs.	Fdrs. conc., dist. 3-core, Callender	..	2,470	..	101 inc.	3=13½ H.P.	Ltg. 6d. & 4d. or 5½d., pr. 4d. & 1½d. or 2½d.	Max. demand & flat rate.	Harold Hale, Engineer-in-chief ..	30
..	40	..	Chloride, 400 amp.-hrs. ..	Overhead, Glover	£2,258	4,800	400	..	9= 24 H.P.	Ltg. 6d., pr. 5d. ..	Flat rate ..	.. ..	31
n,	5,935	3,718	Tudor, 400 amp.-hrs. ..	Triple conc. and single, armd. direct, and solid ..	£339,602	196,000	37,000	367 arc, 2,500 inc.	135=600 H.P.	Ltg. 7d. & 1d., *tr. 5d. & 1d.	Max. demand	Ltg. and traction (725 KW.) *Reduced because tr. dept. has own cables.	32
..	3,102	2,535	E.P.S., 1,500 amp.-hours ..	Jute & ppr. Siemens, ppr. B.I.W., conc., lead covd. armd. direct.	£355,419	120,791	12,068	310 arc, 10 inc.	145=690 H.P.	Ltg. 5d., pr. 1½d.	Flat Rate with discount.	General supply A.C., special supply D.C. in certain areas.	33
..	2,170												
..	600	300	D.P., 20 KW. for 5 hrs. ..	Fdrs. triple conc., dist. 3-core, Callender	£67,000	26,500	8,400	.. ..	16=140 H.P.	Ltg. 7d. & 4d., pr. 4d. & 1d.	Max. demand	Feeds Chislehurst through step-up transformers at 2,000 volts.	34
ll-	60	..	E.P.S., 3 sets, 9 KW. for 10 hrs.	Overhead	..	1,300	..	10 inc.	.. ..	8d.	Flat rate ..	* Messrs. Gillies & Hornidge, engineers & proprietors.	35
..	1,030	590	Tudor, ltg. 300 KW. for 1 hr., traction 250 KW. for 1 hr.	Armd. and solid Callender, solid B.I.W.	£74,000	28,066	2,500	3 arc, 12 inc.	37= 64 H.P.	Ltg. 4d., pr. 3d.–2d.	Flat rate ..	Lighting and traction	36
..	800	306	.. ..	H.p., B.I.W.; l.p., Silvertown and B.I.W., part solid, part iron pipes for both.	..	19,148	5,014	.. ..	10= 51 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand.	.. ..	37
..	760	273	E.P.S., 33 KW. for 7 hrs. ..	V.r. & v. bit. in c.i. and stoneware pipes	£49,000	22,341	5,000	34 arc, 18 inc.	42=150 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand.	.. ..	38
..	132	65	E. P. S., 500 amp.-hrs. ..	Callender	£17,250	4,827	2,327	8 arcs, 90 inc.*	6 = 26 H.P.	Ltg. 6d., pr. 3d. to 2½d.	Flat rate.	*420 inc. lamps to be used for street lighting.	39
e,	534	180	Tudor, 250 amp.-hrs... ..	Fdrs., conc., jute, lead covd. & armd., dist. conc. ditto, Callender direct.	£41,500	11,063	5,460	25 arc.	1 = 18 H.P.	6d., 4d. & 3d.	Scale.	.. ..	40
..	1,700	508	.. ..	H.p. v.r. Silvertown, ppr. B.I.W., l.p. v.r., B.I.W., Glover & Henley ppr. conc., single and twin.	£72,782	34,723	3,737	1 arc.	= 26 H.P.	Ltg. 7d. & 3½d., pr. 3½d.	Flat rate & Max. demand	.. ..	41
ps	600	275	Chloride, 150 KW. for 5 hrs.	Western Elec. triple conc. armd.	£36,521*	13,504	3,554	12 arc, 346 inc.	15=16 H.P.	7d. & 3d. or 6d.	Max demand or flat rate	*Up to 31/3/01. About £17,000 more spent since then.	42
..	1,340	951	.. ..	V. r. conc., ppr., armd., Siemens..	£101,286	50,250	15,150	78 arc, 78 inc.	20=55 H.P.	Ltg. 7d. & 2d. or 4½d., pr. 4d. & 1d.	Max demand and flat rate	A separate D. C. Lighting and Traction Station in construction.	43
..	870	Ltg. 488.	Chloride, 27·6 KW. for 5 hrs.	Conc. v. bit. lead covd. armd. Callender direct and solid	£44,779	15,728	3,963	45 arc, 20 inc.	.. ..	Ltg. 5d. 4½d. & 4½d. pr. 2d., tr. 2d.–1½d.	Rebate ..	Lighting and traction	44
st,	115	..	Chloride, 40 KW. for 4 hrs. ..	Paper in ducts and covd. overhead, h.p. (5 miles), l.p. covd. overhead.	..	..	350	13 arc, 54 inc.	1= 67 H.P.	7½d.	Discounts	A.C. 5 miles to Carlow, driving motor. dynamo. Steam plant at C. as stand-by.	45
..	22	19	.. ..	Ppr., lead covd., B.I.W.	..	..	..	16 inc.	.. ..	6d.	Flat rate ..	.. ..	46
..	900	337	.. ..	Brooks semi-solid, Glover and Henley armd. conc. ..	..	16,017	3,286	.. ..	2 = 12 H.P.	Ltg. 7d. and 4d. or 5d., pr. 3d.	Max. demand or flat rate.	.. ..	47
..	605	349	Chloride, 36 KW. hrs. ..	H.p. paper conc., dist. v.r.	£45,472*	15,417	1,138	20 arc, 267 inc.	40 = 80 H.P.	Ltg., 6½d., pr. 3d.	Flat rate ..	*Year ending 1900.	48
ns	1,700	750	Tudor, 60 KW. for 3 hrs. ..	Bit. fibre, Callender	£133,062	34,556	6,879	331 arc, 19 inc.	7 = 40 H.P.	Ltg. 6d. & 3½d., pr. 3d., tr. 1·9d. to 1d.	Max. demand	Lighting A.C., Tramway Co. supplied with D.C.	49
..	1,000	679	E. P. S., 21 KW. for 5 hrs. ..	Bit. fibre, lead covd. & armd., Callender	£83,542	38,442	4,538	170 arc, 784 inc.	150 H.P.	Ltg. 4½d., pr. 2½d. to 1½d.	Flat rate with discount.	.. ..	50
..	400	217	Chloride, 600 amp.-hrs. ..	Conc. solid throughout, B.I.W.	£30,000	9,000	..	20 arc, 40 inc.	1 = 7 H.P.	Ltg. 7d. & 3d., pr. 1½d.	Max. demand	.. ..	51
..	80	50	D.P., 20 KW. for 5 hrs. ..	Fdrs. triple conc., dist. 3-core, Callender	£20,000	6,600	1,700	.. —	.. ..	8d. & 4d.	Max. demand.	Fed from Bromley at 2,000 v... ..	52
..	498	206	Tudor, 45 KW. for 3 hrs. ..	Fdrs. drawn in, dist. solid, B.I.W. and T.C.C. ..	..	7,600	..	.. ..	20=133 H.P.	Ltg. 6d. & 4d., pr. 2½d. & 2d.	Rebate* ..	*Lower rate after 12 units per 8 c.p., or 50,000 units pr., per annum.	53
..	300	..	Tudor, 500 amp.-hrs... ..	Triple conc. Callender, solid	..	7,200	..	10 arc, 74 inc.	.. ..	Ltg. 5d., pr. 2½d.	Flat rate and discounts.	.. ..	54
..	575	240	E.P.S., 300 KW. hrs	Lead covd. fdrs. in conduits, armd. dist. direct ..	£21,948	14,862	5,064	7 inc.	15= 50 H.P.	7d. & 4d.	Max. demand	.. ..	55
..	260	..	P.T.L., 30 KW. for 9 hrs. ..	Fdrs. triple conc., dist. 3-core, ppr., lead covd, B.I.W.	..	1,219	..	.. ..	2= 11 H.P.	Ltg. 6d. & 2½d., pr. sl. sc.	Max. demand	Lighting and traction	56
..	165	98	Tudor, 20 KW. for 4 hrs. ..	Ppr., diatrine, lead covd., armd. direct, Glover ..	£11,000	27,000	..	32 arc.	1= 5 H.P.	6d., 5d., & 4½d.	Flat rates..	Private ltg. began Jan. 1st. 1901 ..	57
..	1,250	835*	Tudor, 1,700 amp.-hrs. ..	Lead, covd. ppr., B.I.W., lead covd. and armd, jute Callender.	£315,000	27,322	4,288	80 arc. 51 inc.	108=36 H.P.	Ltg. 5d. & 1d., pr. 1½d. to 1d.	Max. demand and sl. sc.	Lighting and traction. *Lighting only.	58
..	550	387	.. ..	Ppr., lead covd., conc.; fdrs. solid, dist. armd. direct B.I.W.	£78,000	26,412	3,500	40 arc.	17=61 H.P.	Ltg. 6d., 3d., 1d., pr. 1½d.	Max.demand flat rate ..	Extension on 2-phase system in progress, 50~.	59
..	400	..	Chloride, 40 KW. for 5 hrs...	Single core, solid in wood, Callender	£25,000	..	..	.. ..	..	Ltg. 5½d.—4d., pr. 2½d.—1½d.	Flat rate with dis.	Lighting and traction	60
..	550	235	Hart, 400 amp.-hours ..	Ppr. & v.r. in wood troughs, Henley	.. ..	9,500	.. ..	3 arc, 686 inc.	14=155 H.P.	6d. & 3d.	Max. demand	Traction under consideration	61
.,	3,215	1,564	Tudor, 1,200 amp.-hours ..	Jute, lead covd. & armd. conc. & triple v.b., solid, Callender.	£171,291	69,000	14,120	382 arc, 24 inc.	.. ..	Ltg. 7d. & 2d., pr. 7d. & 1d.	Max. demand	Lighting and traction	62
..	470	186	D.P., 50 amp. for 5 hours ..	Ppr. & fibre triple conc., armd., direct	£29,000	9,931	6,536	40 arc.	Several	Ltg. 5d. to 4d., pr. 2d.	Sliding scale	.. ..	63
..	200	..	Ashmore, Benson, Pease, & Co., 50 KW. for 3 hrs.	Fdrs. triple conc. dist. 3 core, all ppr. lead covd. solid	£20,000	2,100	..	6 arc, 240 inc.	.. ..	8d. & 2d. or 6d.	Max. demand & flat rate	Works started December 18, 1901 ..	64
1	950	540	Tudor, 500 amp.-hours ..	Armd. fdrs. and dist., also Doulton conduit, Callender and B.I.W.	£40,000	10,975	2,395	18 arc, 150 inc.	30=50 H.P.	Ltg. 4½d., pr. 3d., tr. 1½d.	Flat rates ..	Lighting and traction	65
..	2,300	950	.. ..	Paper and rubber	£125,749	60,000	15,000	80 arc, 200 inc.	100=500 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand	.. .. —	66
..	1,360	500	A. B. P., 75 KW. for 5 hrs. ..	V. b. lead covd. and armd. Callender	£70,000	..	..	.. ..	.. ..	5d.	Flat rate ..	Lighting and traction	67
..	500	250	Tudor, and Chloride, 98 amp. for 4 hrs.	Fdrs., 3 and 2 conc., dist. single, all lead covd. armd. direct. Siemens, Callender, B.I.W. & Waring.	£38,587	18,120	2,706	32 arc, 32 inc.	29=97 H.P.	Ltg. 6d. & 3½d., pr. 4d. & 1d.	Max. demand	Lighting and traction	68
..	688	154	400 amp.-hrs.	Callender fibre	£46,727	11,792	3,244	1 arc.	14=67 H.P.	5d., 4½d. & 3d.	Max. demand	Lighting and traction	69
..	900	510	Tudor, 30 KW. for 10 hrs. ..	Fdrs., v.r. conc., Silvertown; dist. ppr. conc. B.I.W. and Glover in pipes.	£89,865	19,368	2,500	40 arc, 116 inc.	27 = 225 H.P.	Ltg. 7d. & 3d., or 6d., pr. 2½d.	Max. demand. & flat rate.	Ltg. & traction supply	70
3	900	720	.. ..	V.B. conc., solid	£94,000	33,000	2,900	81 arc	8 = 30 H.P.	6d. to 5d.	Flat rate ..	New 3-phase installation in progress	71
..	1,000	..	.. ..	Triple conc., lead cond., and v. bit. Callender —	£45,000	10,000	..	48 arc, 96 inc.	7 = 17 H.P.	6d. & 1½d... ..	Time switch	Lighting and traction —	72
r,	2,299	1,559	E.P.S., 248 KW.-hrs	Bare cpr., v. r., & Callender lead covd. in ducts ..	£73,829	58,858	13,411	67 arc	79	Ltg. 4d. to 3d., pr. 2d., tr. 1½d.	Flat rate, with disc.	Lighting and traction	73
.	200	75	Hart, 240 amp. hrs.	Callender, solid	..	4,000	..	.. ..	.. ..	7d. & 3½d.	Max. demand.	.. ..	74
.	1,130	555	Tudor, 4,300 amp. hrs. for exciting	Jute (h.p.) and v. bit. (l.p.) Callender; some Siemens	£102,953	46,900	7,778 in 9 mo.	72 arc, 1,011 inc.	9=21 H.P.	Ltg. 6d. to 4d. & cont., pr. 3d.	Sliding scale & disc.	Condensing only at top load	75
.	1,200	515	.. ..	Fdrs., ppr., lead covd., solid; dist. ditto & v.r. —	£150,000	43,173	7,788	24 arc	18= 13 H.P.	Ltg. 7½d., pr. 4d.	Flat rate ..	New works in construction	76
.	775	450	.. ..	Fdrs. lead covd. in conduits, dist. Callender, solid ..	—	8,623	..	120 arc, 18 inc.	3= 11 H.P.	Ltg. 7d. & 3d. or 5d., pr. 3d.	Max. demand & flat rate.	Lighting and traction .. .. -	77
.	280	135	Pritchetts, 16 KW. for 9 hrs...	H.p. conc., Glover diatrine, & B.I.W., l.p. twin, Callender, solid.	£19,302	10,374	1,662	2 arc, 426 inc.	2= 6 H.P.	7d. & 2d., & 6d. to 4d.	Max. demand & flat rates.	Traction contemplated	78
t,	10,477	6,007	3,600 amp. hrs.	.. ..	£707,036	312,008	64,074	846 arc	551=2,084 H.P.	Ltg. 3½d., pr. 1½d.	Discount ..	.. ..	79
.	150	..	Pritchetts & Gold	Callender, solid	£20,000	1,450	..	12 arc, 250 inc.	5=19 H.P.	Ltg. 6½d., pr. 3d...	Flat rate ..	.. ..	80
i,	670	412	.. ..	Concentric	£32,000	26,000	4,000	33 arc	12=40 H.P.	Ltg. 6d. to 4d., pr. 3d.	Sliding scale	New station, 1,300 KW., in progress —	81
a-	140	63	.. ..	B.I.W. twin and co.. and oleonite	£11,420	3,050	220	27 arc, 109 inc.	.. ..	7d.	Flat rate ..	.. ..	82
.	380	240	Tudor, 400 amp. hrs... ..	B.I.W. 5-core fdrs., 3-core dist.	£20,500	4,068	..	45 arc, 90 inc.	15=52½ H.P.	Ltg. 5½d., pr. 2½d. to 1½d.	Flat rate ..	Lighting and traction (IF. 200 KW.) —	83
.	120	96	Chloride, 600 amp. hrs ..	Triple core and 3-core ppr. lead covd. and armd. —	£30,000	6,000	1,000	12 arc, 600 inc.	6=27 H.P.	Ltg. 6d., pr. 3d.	Flat rate ..	.. ..	84
.	434	434	Tudor, 170 KW. for 3 hrs. ..	V. bit. solid, triple conc. and 3-core armd. direct, Callender.	£94,500	31,000	..	66 arc, 132 inc.	17=60 HP.	Ltg. 7d., 4d., & 2d., pr. 7d. & 1d.	Max. demand	2,500 v., D.C. feeders .. .. —	85
				Overhead and underground, Glover dia. armd. —	£11,091	4,200	200	6 arc, 80 inc.	2=4 H.P.	Ltg. 6½d., pr. 4½d.	Flat rate ..	.. ..	86

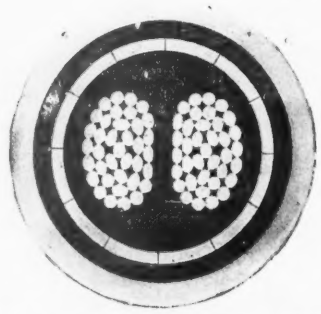
83	FARNWORTH	Urban District Council	1901	J. D. Pember	220 & 440	Direct	3 Lanc., econ. and cond.	ley, 1 Peache, vert., all comp. cond.	Phillips, A.C. ; 2 T. H. arc.			
84	FLEETWOOD	F. & Dist. E. L. & P. Synd., Ltd.	1900	O. Hansom	200 & 400	Direct	2 B. & W., econ., destructor	3 Browett-Lindley	3 Lancashire Dynamo Co.	380	24	
85	FOLKESTONE	F. Elec. Supply Co., Ltd. (Edmundson's).	1898	T. Hesketh	210 & 420	Direct	4 Paxman Economic, surf. cond. (oil burnt in two)	2 Willans	2 Johnson-Phillips	120	9	
86	FORT WILLIAM	F. W. Electric Ltg. Co., Ltd.	1896	I. Reid	150	Direct	6 Peache	6 Parker	1,180	48		
87	CALWAY	Galway Electric Co., Ltd.	1889	A. B. Child	110	Direct	1 Dowson gas producer plant	3 Gilkes turbines	2 Laurence Scott, 1 General Electric.	118	12	
88	CARSTON	G. & Dist. El. Sup. Co., Ltd.	1898 —	P. J. Robinson P. J. Robinson	220 & 440 230 & 493	Direct Direct	2 Lanc. B. & W. with destructor, suphtrs.	2 Browett-Lindley 3 Browett-Lindley	2 Siemens 3 Peebles	120 300	4 ...	
89	CLASCOW	Corporation	1892	W. A. Chamen	250 & 500	Direct	20 B. & W., 6 Marine, stokers, suphtrs., cond.	22 Willans, 4 Belliss, 1 Marine, 1 Ball & Wood.	13 Siemens, 4 Crompton, 2 Westinghouse. 3 Peebles, 2 Walker, 2 Schuckert, 2 B. T. H.	19,200	7,55	
90	CLOUCESTER	Corporation	1900	W. J. Bache	220 & 440	Direct	4 Lanc., stokers and econ.	2 Bellis, 1 Willans	4 Silvertown, 2 Mather & Platt	750	28	
91	CORSEINON	G. Electric Light Co., Ltd.	1894	D. Powell	100	Direct	1 Cornish	1 Thos. White	1 Elwell Parker	22	2	
92	COVAN	Corporation	1900	J. Brown	250 & 500	Direct	3 B. & W.	3 Belliss	2 B. T. H., 1 Silvertown	410	32	
93	CRAVESEND	Corporation	1902	C. F. McInnes	230	Direct	3 B. & W., stokers, econ. and detart.	3 Alley & Maclellan	3 Lancashire Dynamo Co.	600	...	
94	CRAYS THURROCK	Urban District Council	1901	E. D. Long	230 & 460	Direct	2 Lanc. ; destructor & Lanc. blr.	2 Reavell	2 British Schuckert	200	7	
95	CREENOCK	Corporation	1899	W. M. Nelson	250 & 500	Direct	6 B. & W., stokers, econ., surf. cond.	3 comp., 3 triple, Belliss vert.	7 Silvertown	1,100	60	
96	CRIMSBY	Corporation	1901	W. A. Vignoles	230	Direct	4 Lanc., econ., surf. cond. & clg. tr.	7 Belliss	8 Mather & Platt, 1 Westinghouse	680	...	
97	CUERNSEY	Gy. Electricity Supply Co. (Edmundson's).	1900	A. G. Bird	210 & 420	Direct	3 B. & W., econ.	3 Belliss	3 Parker	320	11	
98	CUILDFORD	G. Electy. Supply Co., Ltd.	1896	J. M. V. Money-Kent	215	Direct	3 B & W., stokers, surf. cond.	5 Willans	3 Jackson, 2 Rosling	200	...	
99	HALIFAX	Corporation	1892	W. M. Rogerson	100 & 230	83~, 1-ph.* & direct	4 Lanc., 4 B. & W., stokers and econ.	3 Belliss vert. triple, 5 Pollit hor. comp., 2 Parsons turbines	8 E.C.C., 2 Parsons	2,850	1,65	
100	HANLEY	Corporation	1894	C. A. Cowell	100 & 200	100~, 1-ph.	8 Lanc., econ.	6 Brush, 2 Ferranti	4 Mordey, 2 Ferranti A.C., 2 Brush arc.	1,224	67	
101	HARROCATE	Corporation	1897	G. Wilkinson	100 & 200	50~, 1-ph.	5 Lanc., stokers, econ., suphtrs.	4 M'Laren (2 comp., 2 triple) vert., 1 Parsons turbine.	3 Ferranti, 1 Siemens, 1 Parsons	1,150	54	
102	HARROW	H. Elec. Light & Power Co., Ltd.	1896	E. R. Hill	220 & 440	Direct	4 B. & W., econ.	6 Willans	4 Crompton, 1 Mather & Platt, 1 Siemens	535	25	
103	HASTINGS	Corporation	1883	L. Andrews	200	100~, 1-ph.	5 B. & W., econ., surf. cond. & clg. tr.	3 Brush, 2 Belliss, 1 Parsons turbine, 1 Peache.	5 Brush, 1 Parsons, 1 Crompton	1,235	58	
104	HECKMONDWIKE	Urban District Council	1901	G. H. Carter	230	Direct	2 Stewart, 1 B. & W., suphtrs., econ.	2 Reavell vertical.	2 Fowler	150	8	
105	HEREFORD	Corporation	1899	F. G. Poulton	220 & 440	Direct	2 Lanc., econ., atmo. cond.	3 Belliss vert. (2 comp., 1 triple)	3 Silvertown	450	13	
106	HEYWOOD	Corporation	1900	W. S. Johnston	200 & 400	Direct	2 Lanc., econ.	2 Reavell vert. comp.	2 Crompton	120	4	
107	HICH WYCOMBE	Wycombe (Borough) E. L. & P. Co., Ltd. (Edmundson's).	1898	W. E. Brandreth	210 & 420	Direct	4 Paxman Economic, feed htr.	4 Peache	4 Parker	500	30	
108	HOVE	Hove Elec. Ltg. Co., Ltd.	1892	C. B. Smith	220	Direct	2 Lanc., 5 B. & W., economiser	9 Willans, 1 Belliss	10 Crompton	1,203	73	
109	HOYLAKE & W. KIRBY	Urban District Council	1901	E. Marples	230	50~, 1-ph.	3 Lanc., econ. and suphtr.	4 Belliss	4 Crompton	375	8	
110	HUDDERSFIELD	Corporation	1893	A. B. Mountain	100 & 200	100~, 1-ph.	11 Lanc., 6 B & W., stokers and econ.	3 Brush, 1 Universal ; 1 McLaren	4 Mordey, 1 Ferranti, 2 Siemens	2,200	1,25	
111	HULL	Corporation	1893	A. S. Barnard	110 & 220	Direct	8 Lanc., 1 B. & W., 4 econ.	6 Willans, 5 Allen	2 Holmes, 9 Parker	3,000	2,04	
112	ILFORD	Urban District Council	1901	A. H. Shaw	230 & 460	Direct	3 B. & W., suphtrs. and econ.	3 Willans	3 G. E. Co.	500	28	
113	INCLETON	I. Elec. Ltg. & Power Co., Ltd.	1900	J. Brookes	100 & 200	Direct		2 turbines		20	...	
114	KEICHLEY	Corporation	1901	J. M. Smyth	230 & 460	Direct	2 Lanc., stokers, econ., ejector cond.	3 Allen, vert. comp.	3 Parker	440	12	
115	KENDAL	Corporation		T. N. Ritson	220 & 440	Direct	Fraser's Economic	2 Willans	2 Johnson & Phillips	72	...	
116	KESWICK	K. Elec. Light Co., Ltd.	1890		100	75~, 1-ph.	1 Lanc.	1 Westinghouse, 1 Victor turbine	2 Kapp	60	...	
117	KIDDERMINSTER	K. and District E. L. and T. Co., Ltd.	1900	J. B. Clarke	230 & 460	Direct	5 B. & W., Wilson smokeless process and econ.	3 Brush, 2 Parsons turbine	3 Mordey, 2 Parsons	1,050	...	
118	KILLARNEY	Killarney Electric Lighting Co., Ld.	1893	L. C. Trevor-Roper	100	100~, 1-ph.	1 Loco-type, jet cond.	1 Fowler hor. comp, 1 turbine, 1 water-wheel.	2 Mordey, 1 Ferranti	160	7	
119	KINC'S LYNN	Corporation	1899	J. Pilling	200	Direct	2 Lanc., econ., jet cond., 2 vert. for producer plant.	2 Belliss (steam), 5 Fielding & Platt (gas)	2 Laurence & Scott, 5 G. E. Co.	520	20	
120	KINCSTON-UPON-THAMES	Corporation	1893	J. E. Edgcome	105	77~, 1-ph.	3 Lanc., 4 B. & W., stokers, suphtrs., surf. cond., econ.	10 Belliss vert.	10 Siemens	630	31	
121	LANCASTER	Corporation	1894	W. A. Tester	100 & 200	Direct	2 Lanc., 2 Lanc. dest.	4 Willans, 1 Westinghouse	3 Brush, 1 Mather & Platt, 1 Westinghouse	680	40	
122	LARNE	L. Elect. Lt. Works, Ltd.	1892	M. G. Smyth	100	100~, 1-ph.	2 Corn. induced draught	2 Combe Barbour hor. cond.	2 Mordey	80	6	
123	LEAMINCTON	Midland E. L. & P. Co., Ltd.	1887	F. W. E. Jones	115 & 230	Direct	3 Robey loco., cond.	3 Robey comp.	5 Chamberlain & Hookham	350	15	
124	LEEDS	Corporation	1893	H. Dickinson	100 & 200	83~, 1-ph., 50~, 2-ph.*	14 Lanc., 2 B. & W., stokers, econ., suphtrs. and cond.	1 Fowler, 2 Hick-Hargreaves, 10 Belliss.	4 Ferranti, 6 E.C.C., 3 Fowler	5,940	3,11	
125	LEICESTER	Corporation	1894	A. Colson	100 & 200	50~, 1-ph.	6 B. & W., 3 Lanc., econ.	6 Hick-Hargreaves	4 Ganz, 2 Brush	1,400	1,46	
126	LEICH	Corporation	1899	J. Foster	220 & 440	Direct	2 Lancashire	2 Willans	3 Mather & Platt	160	8	
127	LEITH	Corporation	1899	J. Gray Scott	230 & 460	Direct	4 Lanc., econ.	7 Belliss	7 Silvertown	1,000	54	
128	LEWES	County of Sussex E. P. D. Co. Ltd.	1901	F. H. Davies	230 & 460	Direct	2 B. & W. suphtrs, jet. cond., feed htr.	2 Universal vert. comp.	2 Mordey	100	6	
129	LEYTON	Urban District Council	1896	F. H. Lewis	150 & 300	Direct	4 Paxman, econ.	4 Willans	4 Mather & Platt	908	61	
130	LIMAVADY	L. Power and Light Works	1897	E. J. S. Ritter	110 & 220	100~, 1-ph.		Turbines	4 Siemens	240	35	
131	LINCOLN	Corporation	1898	S. Clegg	230	Direct	5 Marine, econ.	6 Willans	7 Laurence Scott	798	30	
132	LIVERPOOL DISTRICT	Liverpool District Lighting Co., Ltd.	1887	W. M. Horsfall	220	Direct	3 Lanc., stokers, feed htr.	3 Willans, 2 Browett-Lindley	3 Parker, 1 Siemens, 1 Robinson	348	22	
133	LIVERPOOL	Corporation	1883	A. B. Holmes	230 & 460	Direct	64 Lanc., stokers, 5 econ.	58 Willans	51 Siemens, 7 E. C. C.	19,610	9,42	
134	LLANDUDNO	Urban District Council	1898	H. Morton	220 & 440	Direct	4 B. & W., econ.	3 Belliss. 1 Allen, vert. comp.	4 Silvertown	400	39	
135	LONDONDERRY	Corporation	1894	R. V. Macrory	2,150 to 2,500	Direct	2 Lanc., econ., cond.	3 Brown & Sons, vert. comp.	6 Siemens arc.	150	93	
136	LONCTON	Corporation	1901	W. Langford	230 & 460	Direct	2 B. & W., econ.	2 Belliss	2 E. C. C.	300	...	
137	LOWESTOFT	Corporation	1901	G. A. Bruce	230 & 460	Direct	4 B. & W., suphtrs.	2 Musgrave, 1 Browett-Lindley	2 B. T. H., 1 Lanc. Dyno. Co.	475	17	
138	LUTON	Corporation	1901	W. H. Cooke	250 & 500	Direct	2 Lanc., surf. cond., econ., suphtrs., water softener	4 Allen vert. comp.	5 Allen	297	9	
139	LYMINCTON	L. Elec. Lt. & Pr. Co.	1900	E. Hesketh	240 & 480	Direct	2 B. & W., suphtrs	2 Belliss	2 Parker	124	...	
140	LYNTON & LYNMOUTH	Lynton & Lynmouth E. L. Co., Ltd.	1890	P. T. Kimmins	84 & 100	100~, 1-ph.	1 Loco.	1 Sherman (steam) ; 1 Hett, 5 Pelton (water)	2 Mordey, 1 E. C. C.	150	...	
141	MACROOM	M. & Dist. Elec. Ltg. Synd., Ltd.		L. O'Connor	2,000	100~, 1-ph.	*	1 portable, Clayton and Shuttleworth,* 1 turbine	1 Mordey	35	...	
142	MAIDSTONE	Corporation	1901	E. E. Hoadley	230 & 460	Direct	4 Paxman dry back	5 Peache	5 Parker	675	...	
143	MANCHESTER	Corporation	1893	G. F. Metzger	100, 200, & 400.	Direct Direct 50~, 3-ph. 6,500 volts	*Dickinson Street* :—18 Lanc., 4 B. & W., stokers, jet. cond., econ. *Bloom Street* :—11 B. & W., stokers, surf. cond., econ. *Stuart Street* :—36 B. & W., stokers, jet and surf. cond., clg. trs., econ.	6 Galloway, 5 Goodfellow, 2 Musgrave, 2 Ferranti. 4 Musgrave 6 Yates & Thom, 2 Wallsend Slipway, 3 Willans	2 Mather & Platt, 8 E. C. C., 1 Siemens, 2 Westinghouse 4 Westinghouse 11 Electrical Co.	6,710 7,200 16,000	8,8	
144	MARCATE & BROADSTAIRS	I. of Thanet Elec. Tram. & Ltg. Co.	1901	R. Humphries	240 & 480	Direct	4 B. & W., econ.	2 Allis hor., 2 Belliss vert.	4 B. T. H.	1,000	...	
145	MELTON MOWBRAY	M. M. Electric Light Co., Ltd.	1900	W. H. Russell	240 & 480	Direct	2 B. & W., suphtrs., stokers, econ., ejector cond.	2 Parsons turbines	2 Parsons	150	...	
146	MERTHYR TYDFIL	M. Elec. Traction and Ltg. Co., Ltd.	1901	W. S. Olver	230 & 460	Direct	3 B. & W., surf. cond.	3 Browett-Lindley vert. comp.	3 Peebles	300	32	
147	MEVACISSEY	M. Electric Light. Co., Ltd.	1896	J. G. Hill	110	Direct	1 Paxman	Paxman under-type engine	1 Crompton	26	...	
148	MEXBOROUCH	Urban District Council	1902	H. Waring	220	Direct	2 Lanc.	2 Alley & Maclellan	2 Mavor & Coulson	100	...	

! No return to hand.
~ = cycles per second.

The British Insulated Wire Co.

LIMITED.

CABLE MAKERS.



*2 Twin Concentric for Two-phase Working.

PRESCOT, LANCS.

W. RICKARD, Ltd.,

Telephone No. 18. DERBY. Telegrams: "Rickard."

CABLES

WIRES AND CORDS

OF EVERY DESCRIPTION.

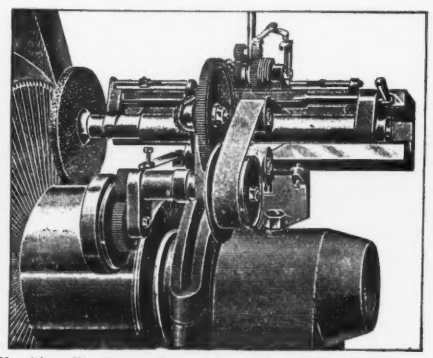
Write for NEW PRICE LISTS AND DISCOUNTS.

PHILLIPS' PATENT

"LIGHTNING"

Automatic Commutator Grinder.

No Motor required to drive it.



Easy to fix.

Machine fixed and Commutator ground in two hours.

JOHN PHILLIPS & CO.,
Engineers,
166, WALWORTH ROAD.

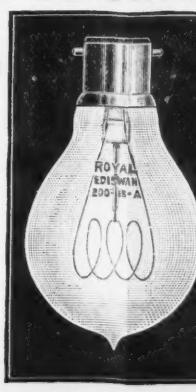
THE . .

ROYAL EDISWAN

Lamps for All Purposes kept in Stock.

ALL VOLTAGES.

Any Candle Power.



16 c.p. High Voltage Lamp. H

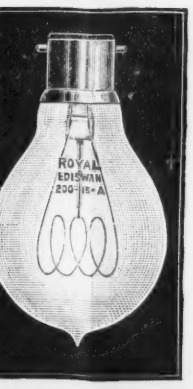
THE EDISON & SWAN UNITED ELECTRI
Ediswan Buildings, Queen Street,

				Callender.											
				Overhead and underground, Glover dia. armd.	—	£11,091	5,000	200	6 arc, 60 inc.	2=4 H.P.	Ltg. 6½d., pr. 4½d.	Flat rate	.. ..	.. ..	
..	380	240	Tudor, 400 amp. hrs... ..	B.I.W. 5-core fdrs., 3-core dist.		£20,500	4,068	..	45 arc, 90 inc.	15=52½ H.P.	Ltg. 5½d., pr. 2½d. to 1½d.	Flat rate	..	Lighting and traction (tr. 200 KW.)	83
..	120	96	Chloride, 600 amp. hrs ..	Triple core and 3-core ppr. lead covd. and armd.	—	£30,000	6,000	1,000	12 arc, 600 inc.	6=27 H.P.	Ltg. 6d., pr. 3d.	Flat rate	..	.. ..	84
..	1,180	434	Tudor, 170 KW. for 3 hrs. ..	V. bit. solid, triple conc. and 3-core armd. direct, Callender.		£94,500	31,000	..	66 arc, 132 inc.	17=60 HP.	Ltg. 7d., 4d., & 2d., pr. 7d. & 1d.	Max. demand	2,500 v., D.C. feeders	.. .. —	85
eneral	118	120	E.P.S., 70 amp. for 9 hrs. ..	Overhead and underground, Glover dia. armd.	—	£11,091	5,000	200	6 arc, 60 inc.	2=4 H.P.	Ltg. 6½d., pr. 4½d.	Flat rate	..	.. ..	86
olmes,	153	84	Tudor, 24 KW. for 3 hrs. ..	Bare cpr. and diatrine single in bitumen trg...	—	£9,612	3,654	110	8 arc, 4 inc.	8=8·5 H.P.	Ltg. 5d., pr. 3d.	Flat rate	..	Water chief source of supply	87
..	120	45	E.P.S., 17 KW. for 4 hrs. ..	Callender single & conc., B.I.W. conc. & triple conc.			5,788	..	.. ..	1=5 H.P.	Ltg. 5d., pr. 2d.	Flat rate	..	Gatacre Works	88
..	300	..	E.P.S., 46 KW. for 5 hrs. ..	B.I.W. triple conc., armd.		.. ..	.. ..	..	.. ..	.. ..	.. ..	.. ..		Garston Works	
sting-ker, 2	19,200	7,550	Tudor, (1) 250 a. for 5 hrs., (2) 1,000 a. for 2 hrs.	Paper and bit. yarn conc. feeders; network, lead and vulcd. bitumen, solid		£836,000	368,342	126,000	348 arc	427=1894 H.P.	Ltg. 6d. & 1d., or 3½d., pr. 1½d.	Max. demand and flat rate		Three stations	89
tt ..	750	284	E.P.S., 1,000 amp.-hrs. ..	Triple conc., Callender, solid		£54,383	16,500	3,500	54 arc	11=25 H.P.	Ltg. 6d. & 2d., pr. 4½d. & 1½d.	Max. demand	.. ..		90
..	22	20	.. ..	Overhead 2-wire, Henley		£1,000	700	150	.. ..	.. ..	6d., & 1s. 3d. per C.P. p.a.	Flat rate and contract	.. ..		91
..	410	320	Tudor, 160 amp.-hrs. ..	3 single lead covd. and armd. cables direct		£35,000	20,000	9,000	100 arc	18=70 H.P.	Ltg. 6d. & 1d. or 3½d., pr. 1½d.	Max. demand and flat rate	.. ..		92
..	600	..	Verity, 500 amp. hrs. ..	Western Electric lead covd., ppr. solid..		£35,000	.. ..	..	27 arc	.. ..	Ltg. 7d. & 3d., pr. 3d.	Max. demand	Lighting and traction (Gravesend and Northfleet Tramway Comp.)		93
.	200	76	D. P., 17 K.W. for 10 hrs. ..	Triple conc. bit. armd., Callender		£15,000	4,000	..	200 inc.	.. ..	7d. & 4d.	Max. demand	.. ..		94
..	1,100	600	Tudor, 100 K.W. for 4 hrs. ..	V. bit., solid & in C. W. casing, Callender		£40,424	28,136	15,656	50 arc.	49=500 H.P.	Ltg. 7d. & 1½d. or 5½d., pr. 2d., tr. 1½d.	Max. demand & flat rates.		Traction supply (250 KW.) to Greenock and Port Glasgow Tramway Co.	95
house	680	..	Tudor, 300 amp.-hrs... .	Fdrs. conc., dist. triple conc., B.I.W. solid		£59,000	11,577	..	65 arc.	.. .	Ltg. 5d., pr. 2½d.	Flat rate	..	Energy supplied to Tramway Co. —	96
..	320	119	D.P., 35 KW. for 5 hrs. ..	Armd. triple conc., Callender		£40,000	..	..	4 arc, 9 inc.	19=48 H.P.	Ltg. 7d. & 3d., pr. 4d. & 1½d.	Max. demand	.. ..		97
..	260	..	Chloride, 300 amp.-hrs. ..	Callender, v. bit. & fibre, iron armd.		£26,855	8,000	2,000	..	..	Ltg. 6d., pr. 3d.	Flat rate	.. ..		98
..	2,850	1,650	Chloride, 150 KW. for 6 hrs...	V. r. Siemens, v. bit. and lead covd. ppr. Callender..		£198,000	61,370	2,600	65 arc, 120 inc.	80=300 H.P.	Ltg. 4d., pr. 2d.	Max. demand	Lighting and traction. * Also 25~, 3-ph.		99
Brush	1,224	677	.. ..	H. p. v. r. and ppr., l.p. Callender single, and B.I.W. conc.		£73,330	44,973	4,549	68 arc, 191 inc.	36=30 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand	.. ..	—	100
ons ..	1,150	540	.. ..	Conc., ppr., lead covd., B.I.W.		£84,600	37,195	5,437	60 arc, 120 inc.	120 H.P.	Ltg. 6d. & 4d., or 6d. & 2d., pr. 2½d.	Max. demand	.. ..		101
att, 1	535	250	E.P.S.	Bare cpr., and Callender in ducts and solid		£56,892	18,000	..	..	14=55 H.P.	Ltg. 8d. & 4d., pr. 4d.	Max. demand & flat rate.	.. ..		102
on ..	1,235	584	Tudor, 65 KW. hrs.	Paper, diatrine, Glover		£120,000	25,666	3,177	104 arc.	5=5 H.P.	6d. or 10s. per an. per lp., & 1½d. per u.	Flat rate & Hopkinson.	.. ..		103
..	150	83	Tudor, 250 amp.-hrs... .	Ppr., solid, Henley		..	5,260	..	10 arc, 122 inc.	1=6 H.P.	Ltg. 6. & 3d. or 5d., pr. 4d. & 2d., or 2½d.	Max. demand or flat rate.	Traction plant to be installed	..	104
..	450	134	Chloride, 660 amp.-hrs. ..	V. r. in bit., Silvertown		£24,500	9,103	1,103	.. ..	10= 35 H.P.	Ltg. 6d. & 4d., pr. 3d. & 2d.	Max. demand	Auxiliaries driven by electric motors		105
..	120	41	Marquand, 300 amp.-hrs. ..	V. bit. and ppr., lead covd., solid		£15,000	2,500	..	4 arc.	5= 21 H.P.	Ltg. 6d. & 3d., pr. 2½d. & 1½d.	Accdg. to lps. installed.	.. . .		106
..	500	301	Tudor, 120 KW. for 3 hrs. ..	Fdrs. conc., dist. 3 core, all armd. direct, Callender..		£60,000	22,170	5,260	10 arc, 230 inc.	97=219 H.P.	Ltg. 5d. & 2d., pr. 4d. & 1d.	Max. demand	Traction under consideration ..	..	107
..	1,203	737	Tudor, 127 KW.	Bare cpr. in ducts, insd. cable in iron pipes		£109,739	61,448	8,535	..	40=166 H P.	Ltg. 7d. & 4d., pr. 3d.	Max. demand	H.P. for motors includes heating	..	108
..	375	89	Chloride, 24 KW. for 5 hrs...	Fibre, conc. solid, Callender		£40,000	12,000	..	308 inc.	1=½ H.P.	Ltg. 7d. & 3d., pr. 3d. & 1½d.	Max. demand	25 KW. motor alternator for charging batteries and taking day load.		109
ens ..	2,200	1,257	.. ..	B.I.W. armd. conc. and Callender, solid		£154,000	100,734	15,081	33 arc, 52 inc.	74=236 H.P.	Ltg. 4½d., pr. 2½d. & 1d.	Flat rate	.. ..		110
..	3,000	2,044	Pritchett & Gold	Bare cpr., Callender bit. and Siemens armd. dist., Siemens conc. fdr. in ducts.		£206,780	112,312	..	12 arc	145=633 H.P.	Ltg. 5d. & 2d. or 4½d., pr. 2d.	Max. demand	.. ..		111
..	500	287	E. P. S., 600 amp.-hrs. ..	Conc. armd. fdrs., solid dist. Henley		£60,000	12,652	..	40 arc, 440 inc.	2=2½ H.P.	8d. & 2d. or 5d.	Max. demand or flat rate	.. ..		112
..	20	..	D. P., 27 H.	Callender 2 and 3 core lead covd. and armd. direct...		£6,000	1,200	138	33 inc.	.. ..	Ltg. 6d., pr. 3d.	Flat rate	.. Water plentiful except during prolonged frost		113
..	440	120	Tudor, 35 KW. for 10 hrs. ..	Jute, lead covd., single, Callender solid		£34,000	..	..	24 arc, 48 inc.	16= 76 H.P.	Ltg. 7d. & 3d. or 5d., pr. 2½d. to 2d.	Max. demand	Lighting and traction		114
..	72	..	Tudor, 20 KW. for 5 hrs. ..	Triple conc., B.I.W.		..	Not yet completed.				6d. & 3d.	Flat rate	.. ..		115
..	60	..	.. ..	V. r. underground and overhead		..	..	..	..	..	6d.	Flat rate	.. Management in the hands of the Windermere Co.		116
..	1,050	..	Chloride.	B.I.W., armd., lead covd., conc.		..	..	..	..	..	Ltg. 7d. & 2½d., pr. 7d. & 1½d.	Max. demand	Lighting and traction		117
..	160	79	.. ..	Callender and St. Helens armd. conc. fdrs., Callender lead covd. conc. dist.		..	3,100	..	5 arc, 38 inc.	.. ..	5d.	Contract & flat rate	.. ..		118
o. ..	520	208	Chloride, 30 KW. for 5 hrs. ..	Fdrs. jute, conc. lead covd. in ducts. & armd. direct, dist., triple conc. armd. direct, ppr. B.I.W. solid		£39,500	10,500	2,620	22 arc, 470 inc.	8=58 H.P.	Ltg. 5d. & 3d., pr.3d. & 1½d.	Max. demand	Steam and gas station		119
..	630	310	.. ..	Armd. conc. Siemens direct.		£50,600	20,000	2,000	41 arc, 23 inc.	18 ..	Ltg. 6d. & 3d., pr. 3d.	Max. demand & flat rate	.. ..		120
West-	680	405	.. ..	Callender		£36,056	28,215	3,625	31 arc, 62 inc.	46=100 H.P.	Ltg. 5d., pr. 3d.	Flat rate	.. Erecting new works for lighting and traction		121
..	80	60	.. ..	B.I.W. armd. direct and solid, and bare copper ..		.. ..	1,700	..	14 arc, 127 inc.	.. ..	2d. to 8d.	Contract & meters	.. ..		122
..	350	151	E. P. S. 1,000 a.h., Hart 1,500 a.h.	Jute, lead covd., fdrs. armd., dist. solid, Callender ..		.. ..	10,118	250	.. ..	7=10 H.P.	Ltg. 7d. & 3½d. or 6d., pr. 4d.	M. d., Hop. & flat rate.	*Also 2-rate meters used	.. ..	123
..	5,940	3,110	.. ..	B.I.W. and Silvertown	—	£368,098	166,889	40,907	1 arc.	155=504 H.P.	Ltg. 4d., pr. 1½d. to 2d.	Ltg. flat rate; pr. max. dem.	No meter rents. *Also 50~, 1-ph.	..	124
..	1,400	1,467	.. ..	Paper conc.		£189,140	101,861	30,518	.. ..	72=192 H.P.	Ltg. 4d., pr. 2d. ..	Flat rate	.. ..		125
..	160	86	Chloride, 150 KW. for 1 hr. ..	Triple conc., B.I.W.		£10,917	4,847	2,874	.. ..	8=138 H.P.	Ltg. 6d. & 3d. or 5d., pr. 3d. & ½d.	Max. demand and flat rate.	.. ..		126
..	1,000	546	E. P. S. 750 amp.-hrs. ..	Triple conc. ppr., direct with steel plates, and solid in wood		£70,000	35,117	8,685	223 arc	73=416 H.P.	Ltg. 4d., pr. 1½d.	Flat rate with disc.	.. ..		127
..	100	64	Hart, 10 KW. for 6 hrs. ..	Western Electric solid		.. ..	3,000	..	2 arc	1=2 H.P.	Ltg. 7d. & 2½d., pr. 7d. & 1½d.	Max. demand	.. ..		128
..	908	618	126 KW. for 4 hrs.	Armd. conc., also lead covd. in ducts for dist... ..		£100,000	31,461	6,137	63 arc, 415 inc.	10=18 H.P.	Ltg. 5d. & 2d., pr .5d. & 1d.	Max. demand	.. ..		129
..	240	35	.. ..	Bare copper		..	1,000	..	.. ..	.. ..	10s. per 8 cp.	Contract	.. ..		130
..	798	300	Chloride, 300 amp. hrs. ..	V. bit. armd., conc. and triple conc., Callender ..		£35,550	17,047	3,821	30 arc, 91 inc.	9=8 H.P.	6d. & 2½d., pr. 4d. & 1d., or 2½d.	Max. demand	.. ..		131
on ..	348	223	E.P.S., 35 KW. for 4 hrs. ..	Callender solid		£50,000	17,530	5,234	12 arc, 18 inc.	3=5 H.P.	Ltg. 6d., pr. 3d.	Flat rate	.. *Gt. Crosby & Waterloo	.. ..	132
..	19,610	9,431	K.L.P. type, E.P.S.	Callender solid		£1,887,621	317,858	62,990	156 arc, 28 inc.	587=2,083 H.P.	Ltg. 4d., pr. 2d. & 1½d.	Flat rate	.. Lighting and traction		133
..	400	397	Pritchetts & Gold 500 amp. hours.	Triple conc. fdrs., armd., lead cov., 3-core dist. direct		£28,057	16,000	..	48 arc.	.. ..	7d. & 3½d. or 6d.	Max. demand and flat rate.	.. ..		134
..	150	93·5	.. ..	V. r. single core armoured		£19,786	..	..	183 arc	.. ..	.. .. ..	.. ..	Only public arc lighting undertaken except 19 private lamps.		135
..	300	49	Chloride 40 KW. for 13 hrs...	Vulc. bitumen, solid..		£19,000	1,533	..	.. ..	3=6½ H.P.	8d. & 2d.	Max. demand	.. ..		136
..	475	171	Chloride.	V. r. conc. fdrs. and dist., Callender, solid		£40,000	10,200	..	54 arc	7=20 H.P.	Ltg. 7d. & 3d., pr. 7d. & 1½d.	Max. demand	.. ..		137
..	297	92	Chloride, 80 KW. for 2 hrs. ..	Callender v. bit. 3-core dist., conc. fdrs.		£26,000	4,020	..	10 arc, 24 inc.	4=8 H.P.	Ltg. 6d. & 3d., pr. 6d. & 1½d.	Max. demand	Supply for traction projected.. ..		138
..	124	55	D. P., 20 KW. for 8 hrs. ..	Callender, triple conc. fdrs., 3-core dist., all armd. ..		£22,000	4,182	2,852	2 arc, 108 inc.	3=6 H.P.	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	.. ..		139
..	150	48	.. ..	Diatrine twin and conc., Glover	—	£7,500	1,850	210	1 arc, 64 inc.	.. ..	6d. Summer, 5d. Winter	Flat rate	.. Hett turbine is being replaced by Escher Wyss		140
..	35	33	.. ..	Conc. lead covd. and armd.		.. ..	.. ..	24	87 inc.	.. ..	4½d.	Flat rate	.. In course of renewal		141
..	675	85	Chloride, 46 KW. for 5 hrs. ..	Callender solid in iron trg.		£40,090	7,058	..	46 arc	7=62 H.P.	7d. & 2d.	Max. demand	Supply to tramways later		142
C., 1	6,710														
..	7,200	8,822	Chloride, 480 KW. hrs. ..	Bare cpr., v.r., ppr., and v. bit., Callender, B.I.W., Glover, Western El., J. & P.		£1,018,633	334,688	25,128	29 arc	719=2,703 H.P.	Ltg. 5½d. & 1½d., pr. 3d. & 1½d.	Max. demand & sliding scale from 5½d. to 1½d.	Tramways supplied temporarily from Dickinson St. pending completion of Stuart St. works, which will supply for 800 cars.		143
..	16,000														
..	1,000	..	Tudor, two, 560 amp.-hrs. ..	B.I.W., conc.		.. ..	.. ..	..	60 arc	.. ..	6d. & 3d.	Max. demand	Lighting and traction		144
..	150	77	D. P. 350 amp.-hrs.	Callender, lead covd. steel taped conc. fdrs., 3-core dist.		£22,000	3,589	2,109	5 arc, 140 inc.	5=29 H.P.	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	.. ..		145
..	300	350	Hart	Callender, triple conc.		..	5,000	..	.. ..	.. ..	Ltg. 7d. & 2½d., pr. 7d. & 1½d.	Max. demand	Lighting and traction, Highfield booster.		146
..	26	..	Epstein	Bare copper overhead		£1,134	..	..	38 inc.	.. ..	7½d.	Flat rate	.. ..		147
..	100	—	Stockton, 40 KW. for 5 hrs...	Callender, solid	—	£18,000	..	..	15 arc, 210 inc.	.. ..	Ltg. 5d., pr. 3d.	Flat rate, with disc.	Refuse destructor		148

BY ROYAL WARRANT ELECTRIC LAMP MAKERS TO H.M. THE KING.

THE EDISON & SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

EDISWAN LAMP.



ECONOMICAL

DURABLE

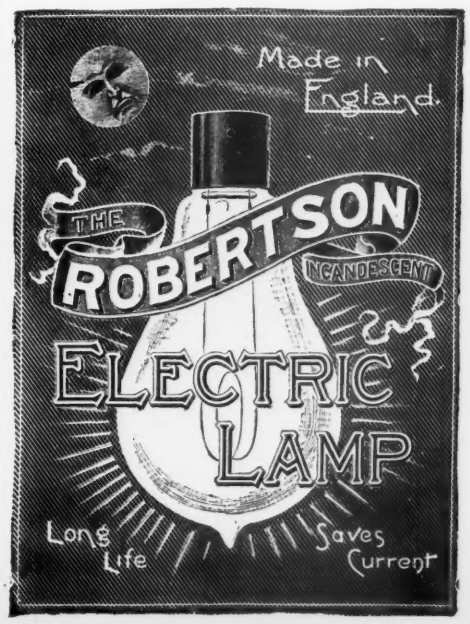
RELIABLE

✦

Best and Cheapest in the end.

gh Voltage Lamp. HALF SIZE.

AN UNITED ELECTRIC LIGHT CO., LTD.
dings, Queen Street, London, E.C.



THE ONLY METER ON THE MARKET.

That always registers the smallest currents.
That never requires re-calibration.

BASTIAN

(APPROVED BY THE BOARD OF TRADE)

METERS

Over 8,000 Sold.

The only simple Meter on the Market.
The only dead accurate Meter on the Market.
The cheapest Meter on the Market.

BASTIAN METER CO., LTD.,
Bartholomew Works,
KENTISH TOWN, LONDON, N.W.

ISIDOR
FRANKENBURG
Limited.

Telegrams:
"SINCOLOR, MANCHESTER."

VULCANISED RUBBER

LEAD SHEATHED.

CABLES & WIRES

TELEPH ONE - No. 5273.

SALFORD,
MANCHESTER.